

VOL-IV

NO-3

Engineering Library  
GENERAL LIBRARY  
MAR 12 1919  
UNIV. OF MICH.

# THE JOURNAL OF THE SOCIETY OF AUTOMOTIVE ENGINEERS



MARCH 1919

SOCIETY OF AUTOMOTIVE ENGINEERS INC.  
29 WEST 39TH STREET NEW YORK

# uniformity

ANSCO COMPANY

BINGHAMTON, N.Y. January 3, 1918.

RESEARCH LABORATORY

American Bronze Corporation,  
Berwyn, Pennsylvania.

Gentlemen:

I am submitting below a short report on Non-Gran Bearing Bronze with a photomicrographic illustration. I am also sending separately a number of duplicate photomicrographs which you may find use for. These photomicrographs were made with the Silvermann illuminator. Some of the prints are darker than others in order to bring out the structure of the copper rich cores.

Very truly yours

*Alfred B. Hitchins*

## REPORT ON NON-GRAN BEARING BRONZE

Recently a number of bronzes have been examined microscopically with a view to determining the uniformity of their structure and without doubt Non-Gran Bearing Bronze exhibits the most uniform formation of any of the bronzes examined. For the purpose of microscopic examination the bronzes were polished and then etched in the following solution:

Distilled water	-----	50 cc
Concentrated ammonia	-----	35 cc
Hydrogen (15 vol.)	-----	15 cc

The etching was continued for 15 seconds. A photomicrograph (165 X) is attached to this report and shows the eutectoid constituents and the copper rich cores. After the photomicrographic work had been completed the sample of Non-Gran Bronze was split up into portions and a series of chemical analyses were made. These resulted in a remarkable similarity of the chemical content of the alloy, further confirming the uniformity of the product.



HIGH SPEED  
**NON-GRAN**  
BEARING BRONZE

Made by  
**American Bronze Corporation**  
Berwyn Pennsylvania

# THE JOURNAL OF THE SOCIETY OF AUTOMOTIVE ENGINEERS

Vol. IV

March, 1919

No. 3



## The Fourteenth Annual Meeting of the Society.

FROM the viewpoints of the importance of the questions discussed, attendance, enthusiasm and value, the Fourteenth Annual Meeting in New York, Feb. 5 and 6, was, it is generally agreed, the best the Society has ever held. As was to be expected, the fuel situation and the problems of aeronautics received considerable attention at the meeting, special sessions on both subjects being arranged through the cooperation of Government departments. President Kettering's address on the more efficient utilization of internal-combustion engine fuel was of the greatest value and held the members spellbound. The standard military truck, tanks and various types of automotive ordnance apparatus were also featured. Some of the papers and addresses appear elsewhere in this issue, while others which are being revised by the authors will be printed in a subsequent issue.

The business session was called to order on Wednesday morning, Feb. 5, by President C. F. Kettering.

President Kettering appointed H. L. Pope, E. W. Weaver and Joseph Schaeffers to act as tellers to count the ballots cast for officers of the Society.

A report was next presented by the Standards Committee on the matters approved at the committee meeting held the previous day. This covered reports on standards and recommended practices prepared by the Ball and Roller Bearings, Chain, Electrical Equipment, Engine, Miscellaneous, Springs, and Tire and Rim Divisions which were approved for submission by letter ballot to the membership at large.

General Manager Clarkson made a brief report on the membership of the Society, which shows the increase of the number of active members from 3218 on Jan. 1, 1918, to 3866 on Jan. 1, 1919.

The ballots cast by the members of the Society for officers were counted during the Annual Meeting. The list of officers elected follows:

President (to serve one year), C. M. Manly, 484.

First Vice-president (to serve one year), B. B. Bachman, 485.

Second Vice-president, representing motor-car engineering (to serve for one year), E. H. Belden, 485.

Second Vice-president, representing aviation engineering (to serve for one year), E. A. Sperry, 478.

Second Vice-president, representing tractor engineering (to serve for one year), T. B. Funk, 483.

Second Vice-president, representing marine engineering (to serve for one year), John J. Amory, 482.

Second Vice-president, representing stationary internal-combustion engineering (to serve for one year), L. S. Keilholtz, 480.

Members of the Council (to serve for two years): E. A. DeWaters, 485; David Fergusson, 484, and E. A. Johnston, 484 (to serve for one year), C. S. Crawford, 485, and J. V. Whitbeck, 484.

Treasurer (to serve for one year), C. B. Whittelsey, 486.

The professional papers presented at the Wednesday morning session included one by Lieut.-Col. Herbert W. Alden, who has been in practical charge of Army tank engineering matters since the Government entered the war, outlining briefly the history of the tank and describing some of the engineering features of the types developed in this country. Other papers presented at this session were by Edward R. Hewitt dealing with "The Principles of Design of the Wheeled Farm Tractor," and by George M. Crouch relating to "The Performance of Marine Automotive Equipment in the War," with particular reference to the submarine chasers.

At the opening of the Wednesday afternoon session President-elect Manly spoke a few words of appreciation of the honor which the Society had conferred on him. The year 1918, he stated, was undoubtedly the greatest year in the history of the Society, and he pointed out that the biggest asset the Society has is the wonderful spirit of cooperation that exists among its members. He emphasized the fact that in spite of the excellent work accomplished in 1918, even better things could be expected during the present year if the members would cooperate as freely as they had in the past.

A symposium on the probable effect of aeronautic experience on automobile practice was the first subject to be discussed at this session. This consisted of three papers prepared by Henry M. Crane, Howard Marmon and O. E. Hunt. "High-Speed High-Efficiency Engines" were discussed by D. McCall White; "The Story of the United States Standard Truck" was told by J. G. Utz, and this paper was supplemented by some remarks by Lieut.-Col. Edward Orton, Jr., on the work and policy of the Motor Transport Corps.

At the Fuel Session on Thursday morning, which was arranged at the request of Dr. Joseph E. Pogue of the Bureau of Oil Conservation, U. S. Fuel Administration, several papers dealing with the subject of Conservation of Fuel were presented. These covered all phases of the problem from the sources of supply and methods of refining to the best way to improve the utilization of fuel by internal-combustion engines.

Aeronautic subjects were considered at the final professional session, which was held on Thursday afternoon. A feature of this session was the presentation of four papers prepared by engineers of the Navy Department who had immediate charge of portions of the naval aircraft program. In addition to these a paper on "The Liberty Aircraft Engine" was presented by Jesse G. Vincent. Other papers dealing with the use of aircraft over land and water were given, including one on "Making the Airplane a Utility," by Grover C. Loening, which dealt with the commercial possibilities of the use of high-speed planes. The factors involved in the design of aircraft were discussed in a paper by Alexander Klemin entitled "Experimental Aeronautical Engineering." The concluding paper of the session was on "Forest Products for Aircraft Use," by Clyde H. Teesdale of the Forest Products Laboratory. This dealt with the research and development work of the laboratory in connection with the finding of suitable material for American aircraft manufacturers.

#### TREASURER'S REPORT

Treasurer C. B. Whittelsey submitted a financial report for the fiscal year ended Sept. 30, 1918, which showed assets amounting to \$79,008.92, approximately \$14,000 of which was cash and \$48,000 invested funds, the remainder of the assets being composed of accounts receivable and inventories. These assets exceeded those of the previous fiscal year by \$19,334.48, cash and investment being increased by \$13,152.81, and inventory and accounts receivable by \$6,181.67. The profit and loss account for the last fiscal year showed income amounting to \$155,627.69. The operative cost was \$140,621.26, leaving a net profit of \$15,006.43 for the year.

#### SOCIAL FEATURES

The social side of the meeting was not overlooked. A reception to the retiring and incoming officers of the Society was held on Wednesday evening at the Hotel Astor. A short illustrated address by Col. W. A. Bishop

of the Canadian Air Service preceded the reception, which was followed by dancing.

The following night the Victory Dinner was held at the Hotel Astor, at which over 1200 members and guests were present. The Hon. Job. E. Hedges, who was introduced by President Kettering, was toastmaster, and speeches were made by Alfred Reeves, general manager, National Automobile Chamber of Commerce; Charles M. Manly, President-elect of the Society; John N. Willys and George H. Houston. These addresses are printed substantially in full elsewhere in THE JOURNAL.

After the dinner the members and their guests went to the Midnight Whirl at the Century Grove.

The Meetings Committee, composed of David Beecroft, chairman; C. F. Scott, acting chairman; Herbert Chase, F. E. Moskovics and F. E. Place, had general charge of the meeting, assisted by a number of committees specially appointed for the Annual Meeting. These included the following:

Committee for the Reception of Speakers—F. E. Moskovics, chairman; A. L. Clayden, G. W. Dunham, H. L. Pope, H. M. Swetland and K. W. Zimmer-schied.

General Committee on Reception and Acquaintance—N. B. Pope, chairman; Norman Bell, R. A. Brannigan, S. N. Castle, W. L. Colt, F. M. Dampman, O. L. Formigle, F. S. Gassaway, Hugo C. Gibson, Joseph Husson, W. E. Kemp, Wm. P. Kennedy, Dr. H. C. McBair, R. M. Owen, A. J. Poole, F. E. Queeney, W. I. Ralph, C. E. Reddig, Alfred Reeves, H. C. Steinau, H. A. Tarantous, Harry Tipper and Joseph Tracy.

Midnight Whirl Committee—G. D. Wardrop, chairman; Norman Bell, W. J. Hart, H. M. Martin and A. M. Wolf.

Entertainment Committee—E. Favary, chairman; Hugo C. Gibson, H. W. Slauson, A. F. Wagner and C. J. Welch.

Luncheon Committee—Charles F. Chapman, chairman; T. H. Marburg, C. H. Tavener and H. W. Uhl.

## RECENT COUNCIL MEETINGS

AT the meeting of the Council held Jan. 23, 1919, in New York City, Vice-presidents Houston and Funk, Past-president Dunham and Councilors Manly, Bachman and Whitbeck were present. The final plans for the Annual Meeting were outlined and approved and report made on the holding of a Society meeting at Chicago on Jan. 30, a Motor Truck Meeting at New York City on Feb. 10, a Tractor Meeting at Kansas City during the Tractor Show week, beginning Feb. 24, and an Aeronautic Meeting at New York City on March 7 during the Aeronautic Show.

The Membership Committee reported that the total membership of the Society on Jan. 1, 1919, including affiliate member representatives and enrolled students but not Section associates, was 3866 and that 958 applications had been received in the calendar year and 989 applicants had qualified. The issuing of an identification card bearing an outline of the Society's pin and signed by the Treasurer was approved. It was also voted to permit service and foreign members to wear the blue pin worn by members of the Society. Individual membership applications to the number of 140 were approved,

together with 2 for affiliate membership. The following transfers of membership were made:

*Associate to Member Grade*—R. H. Campbell.

*Member to Foreign Member*—K. Fujita and Joseph A. Mackle.

*Junior to Member Grade*—E. R. Ritter.

The resignations of the following members were accepted: R. A. Bachman, F. A. Law and John B. Peddle; as were also those of the following associates: H. W. Griffith, R. W. Reed and C. E. Wade. An application from Rene M. Petard for Life Membership in the Society was received and approved.

The following changes in affiliate member representation were made: the Boening Airplane Co. withdrew the name of J. W. Miller from its list of representatives and added those of C. L. Egtvedt and E. V. Johnson, and the Minneapolis Steel & Machinery Co. withdrew the name of George L. Gillette.

It was reported that Part I of the 1918 Transactions would be ready for distribution during March.

The following subjects were assigned to Divisions of the Standards Committee:

## RECENT COUNCIL MEETINGS

139

## ELECTRICAL EQUIPMENT DIVISION

Impulse Starter Couplings

Rating of Storage Batteries for Farm Lighting Equipment

## IRON AND STEEL DIVISION

Spring Steel Specifications

## MISCELLANEOUS DIVISION

Brake Shaft Bushings

Exhaust Heater Connecting Flange

## SPRINGS DIVISION

Brinell Transverse Bend Test

Method of Greasing and Oiling Spring Bolts

Spring Bolts for Commercial Cars

Spring Bolts for Passenger Cars and Spring Pins for Commercial Cars

Test of Commercial Spring Steel

## TIRE AND RIM DIVISION

Base Bands for Industrial Truck Tires

Amendments to Sections B1, B2, B16, B19, B22, B32 and B35 of the By-Laws and R4 of the Rules, proposed at a previous meeting of the Council were approved. [The By-Laws and Rules in question, as amended, are printed on another page]

## MEETING OF FEBRUARY 4

At the meeting of the Council held in New York City Feb. 4, 1919, Vice-presidents Beecroft and Hinkley, Past-president Dunham, Councilors Bachman, Crawford and Whitbeck and Treasurer Whittlesey were present. The report of the auditor covering the audit of the accounts of the Society for the fiscal year ended Sept. 30, 1918, was read by Treasurer Whittlesey, who also submitted verified balance sheet and profit and loss account. The plans for the Annual Tractor and Aeronautic meetings were discussed. Individual membership applications to the number of 70 and 7 applications for affiliate membership were approved. The following transfers of memberships were made:

*Associate to Member Grade*—Joseph F. Goffin, W. E. Day, Jr., Herbert M. Smith.

*Member to Foreign Member*—Richard Coulson.

*Junior to Member Grade*—G. Edward Barnhart, Austin Weld Deyo, Herman Hollerith and R. B. Mudge.

The reports of the following Divisions of the Standards Committee submitted at the general meeting of that Committee, Feb. 4, were approved: Ball and Rolling Bearings, Chain, Electrical Equipment and Miscellaneous. The report of the Engine Division was approved

for truck practice only, and that of the Iron and Steel Division was referred back to the Division in accordance with the recommendations of the Standards Committee, the Council suggesting the advisability of indicating desirable differences in practice for open-hearth and electric steel castings. The report of the Springs Division as amended by the Standards Committee was approved except as to the item referring to grinding or finish of spring leaves, which was referred back to the Division for further consideration. The recommendations of the Tire and Rim Division pertaining to solid tire and wheel sizes were referred back to the Division, pending a further report from the National Automobile Chamber of Commerce. The question of wood spokes was referred back to the Division with the suggestion that unnecessary details be eliminated and the recommendations be confined to essential engineering dimensions, especially as affecting standard billet sizes for certain hub sizes. The action of the Standards Committee approving the recommendation of the Tire and Rim Division relating to base bands, was confirmed.

The subject of tolerance on corner radii of races of ball bearings for high speed after grinding to fit fillets was assigned to the Ball and Roller Bearings Division for consideration.

## MEETING OF FEBRUARY 7

The organization meeting of the new Council was held on Feb. 7, with President Manly in the Chair. Past-president Kettering, First Vice-president Bachman, Second Vice-presidents Belden and Keilholtz, Treasurer Whittlesey and Councilors Crawford and Fergusson were present.

The important subject of fuel research, outlined so well by authorities at the meeting of the Society on Feb. 6, was discussed. A committee on the whole question of problems involved, ways and means and methods, was established, with Mr. Kettering as chairman.

David Beecroft was elected a member of the Council for the year, to fill the vacancy created by Mr. Manly's election as President.

The acceptance for another year of the chairmanship of the Standards Committee by Mr. Bachman was announced by President Manly.

The next meeting of the Council will be held in New York City on March 8, the day following the Aeronautic Meeting of the Society during the Aeronautical Exposition.

## HENRY SOUTHER

MRS. HENRY SOUTHER has made the following affecting and most highly appreciated acknowledgement of a memorial booklet sent her by direction of the Council in fond recollection of the late Major Souther:

Sapelo Island, January the eighteenth.

The Society of Automotive Engineers,  
New York City.

Gentlemen:

It is difficult to express my deep appreciation of the copy of resolutions sent me.

Major Souther's whole professional life was cen-

tered around the Society of Automotive Engineers, for whose welfare he had the greatest desire and affection. That it should have been appreciated and returned is a joy to his family.

While touched by the contents, I must add my admiration for the beautiful book and its wonderful artistry. All my family and I are glad to have it. We also feel sure it will be an inspiration to Major Souther's two grandsons who will, we hope, some day be members of his beloved Society.

Yours gratefully,

(Signed) ELIZABETH SHERMAN SOUTHER.



# Addresses at the Victory Dinner

**T**HE Annual Meeting terminated on the evening of Feb. 6 with a Victory Dinner in the grand ballroom of the Hotel Astor. Over 1200 members and guests attended. The Hon. Job E. Hedges, who was introduced by President Kettering, was toastmaster. Other speakers were Alfred Reeves, general manager, National Automobile Chamber of Commerce; Charles M. Manly, president-elect of the Society; John N. Willys and George H. Houston. The remarks of these speakers are printed substantially in full on the following pages.

## ADDRESS OF HON. JOB E. HEDGES

**I** ASSUME that an automotive engineer is a sort of self-starter, getting everything out of the way as soon as he gets under motion. It follows, therefore, that we know exactly what the Germans think of us Americans. They did not wait to get into contact with us. It is proper that a part of our festivities should be given to celebrating the victory to which we all contributed so markedly. While some of you men were engineering, digging trenches and constructing fortifications, there were some of us at home who had to beg money to support those abroad and to construct an attitude of mind on the part of the public which would resist all the attacks of insidious propaganda, with its attendant weakening of morale. There were also men in doubt as to where they really belonged. They were abundantly informed, however, where their proper place of location was. Some were conscripted and, refusing to fight, were committed to jail. I regret to say that many of these, however, have been discharged with full pay and restoration before the soldiers who did the fighting were given opportunity to resume their peaceful walks abandoned for the war. There are some who were vociferous in their talk before the war, whispered during it, and finally ceased from vocalizing only for reasons of physical safety. In the last mentioned phase of their conduct they indicated real wisdom. They knew better than to belong to the automotive class.

It can be truthfully said that we helped win this victory. It cannot be said, and should not be, that we were the only element in winning the great conflict. I have always envied an engineer because he is taught to rely and necessarily relies on himself. An automotive engineer is entitled to a peculiar meed of praise. Once upon a time I tried to conduct an automotive campaign. Candor compels me to say it was not a success. Possibly one reason was that at that time tanks had not been constructed.

When an engineer strays from his accustomed environment, wanders into the realm of psychology and talks about vision, I frankly admit a degree of confusion. Speaking as an engineer, I view the difference between the German idea of efficiency and ours to be that the German Government reduces men's minds and hands to a common plane of efficiency, leaving the only freedom that of receiving and taking orders. We appeal directly to a man's soul to arouse his vision, so that he takes his own orders from his own intelligence, and our combined action, therefore, represents efficiency, mental, moral and physical merged into a composite of activity which becomes irresistible. This, among others, is the reason

why the Germans were so necessarily and decisively defeated.

With all the temporarily dreadful results, it will ultimately be a good thing for America that the Kaiser has lived, and a good thing for the world when the Kaiser finally is committed to the place that Col. Whittelsey so aptly designated as a proper resting place for the Hun soldier. The Kaiser has thoroughly taught the world what to avoid as a condition of wholesome living, and that his theories furnish no foundation for a structure for modern civilization. He has also demonstrated that a man is at his best when forced to admit that there is something bigger than he is.

Thus it is that the engineer is the best one who admits that the profession of engineering is larger than himself. Engineering becomes a profession when the picture painted and hung represents on the canvas what can best be done for the human race by the individuals who are leaders in thought and action. It is as impossible for a person to live without exercising influence as it is unrighteous that he should attempt so to do. As a matter of logic, entirely apart from morals, no one can intelligently segregate himself to the plane of mere enjoyment and disregard duty as predicated on service. Nor, on the other hand, is our duty confined to our immediate environment. People smile in their own language. The international language is that of ideas, which indicates that human suffering wherever found speaks to every other normal human being in a language easily appreciable and easily responded to in sympathy and assistance. Thus it is that in whatever language we speak, we can readily communicate our ideas to those who are suffering in the cause of righteousness. This is as far as the doctrine of nationalism can well be carried.

When the Kaiser, referred to merely as a type, started out with the assumption that human intelligence, emotions and men's souls could be kept within the confines of his dictum, he insulted Almighty God, as well as man's intelligence, and started inevitably on the road to destruction. The man who has not felt through the war a keen thrill, who has not believed and understood that there is a bigger thing in government than his mere relationship to it in receiving benefit, has not learned the lesson of the war. If we stand for anything as Americans, we stand for those wholesome, decent things which we will share with the people of the earth and which we will not endeavor to enjoy in the selfish seclusion of isolation. By this I mean that the United States must always be alert and ready to contend for the maintenance throughout the world of those principles on which we base our own civilization, when those principles are attacked and their practice threatened.

The crucial test of the American people is yet to come. It lies in the problems of sustained endeavor, in the prosaic application of fundamental principles in the approaching years, unaccentuated by the thrill of war or the exultation induced by visible and audible attack from without. Probably no man in this room will live long enough to see American thought as evidenced in its Constitution and traditions restored to primal place. The passion for change, the tendency to novelty, and the political competition for publicity incident to startling advocacy, keep the public mind disturbed and aroused.

## ADDRESSES AT THE VICTORY DINNER

141

There is a constant wrenching and straining for something that is new in law without reflecting that in the vast majority of instances there is already enough law properly applied to meet changing conditions and that many of the problems presented have no place in the realm of law, but are social propositions where we seek to shun individual responsibility by shifting the whole question upon the shoulders of officialdom. The standards and ideals of the fathers need study only to insure the revival of an inspired Americanism. As long as there are people sufficiently unintelligent among our members to be deceived, there will always be intelligent minds without moral principles to take advantage of that ignorance for self-exploitation. The responsibility of information, of knowledge, of acquirement, of education, of social and moral wealth, demand peculiar responsibilities toward those less favored. The Republic has a right to expect and to demand from the well capacitated that they shall never institute civic discussion from false premises, and that in talking to those who have a right to look up to them, they shall never deceive. For instance, we did not go into this war to preserve democracy or establish it. We went into this war because our international rights had been attacked and to further condone that attack and violation without rebuking it by armed conflict was to admit that we were without a potential sovereignty. The discussion of preserving democracy for the world or the world for democracy was a proposition that arose afterward, as the vision of the war, unappreciated in its beginning, gradually unfolded to our people. The sustained endeavor of being in the war required for the average mind, not logically but practically, a broader basis than the violation of an international right. Now that the enemy has been defeated, democracy, as popularly known, has been unsuccessfully attacked. Whether it will be affirmatively a successful doctrine and practice and reach to the farthest confines of the world, depends not upon the force of arms, but largely through precept and example. In other words, the possibility and strength of self-government, we can say, without undue pride, is best exemplified in our own form of government. Should we be unsuccessful in maintaining our own standards and meeting under our form of government new and developing propositions, and demonstrate as a result that we are unsuccessful, it will destroy hope throughout Christendom. Therefore, as a matter of substance, with the war over, we are fighting the battle of democracy at home for our own selfish purpose, and in doing that through our example will make it more firmly established throughout the world.

Treason to our Government can come from treasonable utterance as well as treasonable conduct. One who listens without rebuke to treasonable utterance in substance adopts it and is therefore in fact against the Government to which he theoretically bears allegiance. He who compromises with the Bolshevik, either materially or mentally, permits that doctrine to progress and substitutes fear for stability in life. Of all bodies of men whose profession requires them to act according to strict scientific lines, to think by rule and formulas and thus work up to their aspirations, with the broadening effect of vision and art combined, that class of men is represented by those whom I am addressing tonight. Therefore, I make an especial appeal to you gentlemen, that you shall contribute your part, as no doubt you will, through the vast scope of your activities to help make it worth while for a man to be able to say "I am an American citizen."

Great as are the heroes of the air, great as are the men who have come back to us from service on or under the ocean, on land or sea, adorned with honors, welcomed with garlands, and with mind alert to the sacrifice that has been made, there still remains many a hero at home who has had equal longing to go over there or contribute his life, and whose heroism is shown by the quiet unproclaimed martyrdom with which he has lawfully met duties and at the same time helped contribute to those who did the actual fighting. Heroism hereafter will be marked in the enervating times of peace by the monotonous life of daily duty, where the sacrifice is that of ambition, of wealth, of means, of health, of time, in pursuing silently the dictates of patriotism so genuine that it has neither to be advertised nor bragged of. So sincerely do I feel for men of that class that I am the enemy of anyone who seeks to remain in this country and is unwilling to live according to the letter and spirit of our laws and follow thereby the dictates of our courts and our procedure. To permit such persons to remain here is to pollute our own citizenship. We read in the public press of the contentions of labor, of capital, of organization, the struggle for efficiency, the right to live and let live, the strife as to who shall say how another as well as himself may pursue his daily walk. These things will never be finally solved by argument, statute or uniformed authority until an attitude of mind is established which recognizes that the real test for the right to prefer personal advantage is made subordinate to a duty to Government itself.

A peculiar situation has arisen from the war. Among the Allies, naming them just for illustration, we Americans have always had our enthusiasm aroused by mention of the French. It is an anomaly of history that the French monarchy made democracy possible in this country. It is a further anomaly that it was our democracy that helped establish a representative form of government upon the foundations of that very monarchy. Since then we have enlisted our Army and Navy and sent them abroad to help preserve, with our own rights, that same French democracy attacked by a monarchy which grew out of original conditions that in early years furnished precedents for democracy itself.

Sentiment is a bigger, grander thing than law. Each, however, requires the other. The passion for power is instinctive. The continuation of power unduly centered means tyranny. The passion for liberty is a protest against that tyranny. At this point sentiment assumes its sway and by its protest against tyranny furnishes the opposition to overthrow that very tyranny, and the measure of service is marked by the intellect which determines our proportion of effort we are willing to make to sustain the sentiment which we feel.

I can understand the remark that theoretically the engineers regretted that the war could not have continued further until the preparations scientifically made for overcoming our enemy could have been put fully into practice. That thought is consistent because, while no one would like to have lost an added life, it would have been satisfying to demonstrate that a democracy could have furnished in its fight for freedom means of contest more effective than could our natural opponent, a concentrated form of government typified by a monarch. However, had those plans been fulfilled there would not have been enough Germans left to reorganize and pay the indemnities. A repenting Hun working to pay the price of his bad judgment and brutality is better than a dead German unregenerate.

## ADDRESS OF JOHN N. WILLYS

I BELIEVE that the time has come to change our theory of labor; that the old idea that the capitalist's and the manufacturer's sole aim is to get everything he can out of his labor and give him as little for it, is wrong. I think that when Mr. Ford put the \$5 per day program in operation he made the biggest hit of his life. The next day after Mr. Ford promulgated his \$5 per day plan, my general superintendent came to me and said, "Mr. Willys, what are we going to do? All our men are going to leave us and I do not know what we are going to do." I said, "Well, Harry, they cannot all leave us, because Ford cannot take all of them." The superintendent asked if we could put this same plan in operation, and I said we could not. That was the way I felt about it at that time. If I had to do it over, I would not have been 24 hr. in following Mr. Ford's plan. He proved that it was a successful plan from the standpoint of the manufacturer. The man who made radiators made twice as many, because he drove the men. He found the very best labor in the industry would come to him for employment.

I believe in the plan which we are going to adopt of dividing the profit above just compensation for capital. Of course, the lawyer will see that is definitely understood that if we divide the profit we shall get the co-operation of our labor. We are not going to have to drive the labor as Ford did, but are going to get each employee to drive every other employee in our institution to do his duty, to give us a fair day's work. In one of the institutions in which I am interested, we started a piecework plan. One operator on a machine, who had been producing a certain number of parts at day labor and a good day's labor, when this piecework plan was put in operation, gave us the very next day three times as many parts as he did under the old scheme. That shows that labor was not cooperating. While we hear talk about what capital must do, I can say tonight that labor must do its share as well as capital.

I believe that there are a great many ways in which the work will be improved. One will be departmental efficiency. When one department struggles against another for position, we will, I believe, get great efficiency. I am satisfied that the plan can be worked out. I did not hesitate to put it into operation the first of the year. I think that the way to work it out is to not try to settle details before you start, but to set a date for the plan to go into effect, working out the details later.

## ADDRESS OF PRESIDENT-ELECT MANLY

THE thing that impresses me more than anything else in connection with the whole war work is the value of cooperation, and foremost the vast amount of cooperation of the engineers. It is well known that most business men have felt that engineers could not co-operate. This war, if it has done nothing else, has proved to the business men of the country that engineers can cooperate.

The work that lies before us now is much more important than what has gone before. The need of co-operation in solving the great problems confronting us, to which our vision has been led by the work during the war, is imperative. The importance, which has been emphasized by Mr. Kettering, of keeping the front door open so as not to shut out many times more than you have in your shop, has been exemplified by the history of this Society more I think than by that of any other society of this or any other country. Starting with the

automobile trade, and taking the work of the automobile engineer, who was the typical kind of engineer in the Society originally, there is certainly no other body of men in the country devoted to work which involves design and construction requiring vision, in which there is that spirit of wanting to bring everything in through the front door and being careful to avoid locking anything out. A great many people have said that the great conflict we have had was an engineer's war. The question has frequently been asked, "What is an engineer?" It seems to me that the war has helped to answer that to a very large extent. There has never been a business in which the fact was demonstrated so clearly that there is no line of work in which all men who really know how to do things, cannot cooperate to produce the big result. This war has certainly brought to the fore men of every walk of life, of every profession, of every line of thought, and welded them as one. The various thoughts merged into one big, main idea of winning the war, concentrating all attention on that. Now, if we can all concentrate on the big thing that lies before us, which is not merely the building up of trade, but the building up of a strong feeling that this is our country, that we have commenced to take a great deal more interest in it than ever before, and we give to the large questions that lie before the country even a small fraction of the attention we have given to the work of the war, the benefits that will accrue to the country will be very great.

I hope that our work of the coming year will demonstrate that the letters S. A. E. stand not only for Society of Automotive Engineers but for Society of American Engineers.

## ADDRESS OF ALFRED REEVES

ON behalf of the manufacturers, who are deeply interested in your work and your welfare, I am glad to greet the members of the Society of Automotive Engineers, who are making history in this country. I am particularly glad to greet those engineers who spent the past year with us in Washington, where they did such great work for the war. The war has been a great binder for the men in the automobile industry. It brought even greater cooperation than ever before, which I know will continue and broaden.

Thanks to the efforts of you men in cooperation with the automobile manufacturers, there is now a real appreciation, not alone at Washington, but throughout the country, of the merit of the automobile. Congressmen admit that the passenger car, as well as the truck, has its utilitarian value. They declare the proposed new taxes on the industry are made necessary by the war. However, they no longer put automobiles in the class with luxuries. While we must agree that the taxes are unfair and discriminatory, if necessary to pay our war debt, the automobile manufacturers and dealers are not going to lack in patriotism.

It behooves the automobilists to get even more highly organized than they are now, to educate our law makers and the public why the time has passed when an automobile owner should be singled out for special taxes not placed on other users of the roads.

We have got some great problems in our country, as well as in our industry, but this is a great nation and I have no fear of the final outcome. I have a profound respect for American good sense and balance. What we want in this country is thinkers, not tinkers; optimists, not pessimists; doers and not doubters; constructionists



A PORTION OF THE GRAND BALLROOM OF THE HOTEL ASTOR, NEW YORK



THE HOTEL ASTOR, NEW YORK CITY, WHERE THE VICTORY DINNER WAS HELD.



NER OF THE SOCIETY WAS HELD ON FEB. 6.

an  
blo  
a  
de  
ge  
the  
op

I  
see  
tic  
wo  
sa  
sp  
th  
fa

an  
lov  
ga  
sp  
ad  
oth  
re  
co  
tra  
me  
A

T  
fly  
gr  
W  
pr  
co

th  
of  
co  
wh  
an  
m  
vi  
ze  
pa  
ha  
ha  
m  
th  
ve  
ci  
in  
se  
th  
If  
ou  
fo

th  
th  
in  
de  
ou  
th  
re  
so

## ADDRESSES AT THE VICTORY DINNER

143

and not obstructionists. What we need is men with real blood who are willing to speak for the right. We want a square deal for capital and for labor, and a square deal by capital and by labor. This automobile industry, gentlemen, is leading the way for the cure of much of the unrest of which we hear. It has been a great co-operative industry with always great care of the workers.

My faith in the men who are in this room is such that I have a vision of what the future is going to bring. I see wonderful tractors helping to raise food for the nations of the world, with gas engines doing the heavy work on farms in this great gasoline age. I see airplanes, safe, easy to handle and capable of landing in small spaces. I see a great network of good roads throughout the country as an answer to the only present limiting factor to increased sales of motor cars and trucks.

I see automobiles much lighter, more carefully made, and with engines and carbureters capable of handling the lowest grades of fuel, and supplying greater mileage per gallon of fuel than at present. I see cars with concealed spare tires and concealed folding tops. I see cars with adjustable seats, better spring suspension and scores of other improvements which the public demands and is ready to pay for. And, above all, I see the people of the countries of all the world, with their products, being transported quickly and cheaply in wonderfully efficient motor vehicles designed by the real genius of today, the American automotive engineer.

## ADDRESS OF GEORGE H. HOUSTON

THE science of aeronautics has developed the airplane and the balloon, an aeronautic industry, and great flyers. It has developed throughout the world a group of great engineers. It has given those men who led us in Washington in the development of the whole aeronautical program an opportunity to see what a real man's job could be and how it could be handled.

Our great thought lies with the future. A year ago, at the S. A. E. dinner, we listened to an able presentation of the plans of the aeronautical development in this country from a military point of view, and those of us who were engrossed to the absolute limit of our mental and physical capacities in executing that program were much encouraged by what we heard. We saw then the vision of a great air fleet, and as a member of the citizenry of this country, who have been working for the past year in this industry, I want to say I am proud to have spent it with those men and under that plan. I have seen it work out from nothing to one of the great movements of America in the war. The war is over now though, and we see a great science, a great industry developed, and a great art which should be an addition to civilization for all time to come. For the moment standing still, marking time, we are all trying to readjust ourselves to the peace-time conditions. We are trying to get the perspective that we must have before we can go on. If I can give you gentlemen the least indication of what our future in this industry can be, I will feel that my efforts have been thoroughly repaid.

It has seemed to me that in looking ahead the first thing we must do is to formulate more perfectly our theories of aeronautics, our theories of human flight, into an exact science, and crystallize it into tangible, definite data upon which to work. This science today is out of its swaddling clothes, but it is still very immature; those of us who have been working with it for a period realize that much more than the average man. As this science becomes crystallized, our engineers must continue

to apply it. We cannot develop aircraft like manufacturers want to build automobiles, because we are some fifteen years behind the automobile. We have got to remain flexible in our ideas; we must respond quickly to the new thought, the new conception, the dream of the inventor. We must keep our designs up to date.

Flight is in the air, over the land, over peoples' houses, and over everything which in the mind of the law is sacred. We have got to develop an entirely new theory of Governmental control. We do not yet know what the law of the air should be; we do not know yet what it can be; we have, as it were, to develop a theory of the fourth dimension before we can establish this legislation. And yet, gentlemen, aircraft can never come into common use in any country until there is a body of laws that will enable us to govern it, to protect ourselves from the reckless and criminal, without discouraging or interfering with legitimate flight.

We must, then, begin at once, with the end of our war work, and put the entire aircraft industry through a period of disorganization, and then have a reorganization. When the armistice was signed the war ended. At that time the aircraft industry as a whole was one of the greatest transportation industries of the world, ranking equally with any, except possibly that of steamships. It must immediately reduce itself to only a fractional portion; it must do that without loss of morale, initiative, or any of the resources or personnel or capital that it needs. We can thank God that in the S. A. E. we have a great automotive industry into which this excess of plant facility organization and capital can flow.

If we go about this disorganization courageously and carefully, without hysteria, but without any illusions of what the present means, then as the future develops we can again reconstruct. It is of the most vital importance that at this time we carry out this disorganization properly, so that as the period of reconstruction begins we can have a record saying, "Careful management of the liquidation of the investment without undue loss and of the transfer of personnel without injury to that personnel." If we do that, when the reconstruction period commences we can bring back into this industry the facilities and men and capital that we need.

Finally, we must face the application of the airplane to our daily life. This is one of the most fascinating problems ahead of us. We talk with ease about the use of the airplane and the balloon for military purposes; we have talked with the Post Office authorities on the problem of carrying mail; we have discussed with South America the problems of flight, for both mail and passenger purposes. But we are just scratching the surface of the possible application of this wonderful thing that is coming into our lives. What we do with it, as compared with England, France, Italy and Germany is going to depend upon us. If we as American citizens expect to stand shoulder to shoulder with these people abroad, who have learned even better than we what cooperation means, we have got to do it through such an organization as this.

In redeveloping the whole aeronautical science for peace-time purposes, the whole aeronautical industry for the future, we must depend first of all upon the engineer. If you perform your task properly, if you develop this science, if you apply it in a practical way in the design of your product, if you teach the people how your articles can be used in everyday life without destruction of life and property, a decade from now we will have in process of development one of the greatest, if not the greatest, transportation industry of our country. In this development the Society of Automotive Engineers must lead.

# The Officers of the Society

**W**ITH the election of Charles M. Manly to the presidency of the Society a vacancy was created in the membership of the Council. This was filled by the appointment of David Beecroft by the Council in accordance with the provisions of the Constitution. The careers of the men who will guide the work of the Society in the coming year are outlined briefly in the following paragraphs:

## CHARLES M. MANLY

President Manly was born at Staunton, Va., April 24, 1876, and received his early primary and academic education in South Carolina. He was graduated from Furman University, of which his father, Dr. Charles Manly, was president, in 1896, with the degree of master of mathematics and mechanical philosophy. He then took mechanical and electrical engineering courses at Cornell University, being graduated therefrom in 1898 with the degree of mechanical engineer.

When, in the spring of 1896, Professor Langley, secretary of the Smithsonian Institution, applied to Dr. R. H. Thurston to recommend some engineer to take charge of the work which he was then undertaking for the War Department in the construction of a man-carrying airplane, Mr. Manly was recommended by Doctor Thurston and took charge of this work under Doctor Langley's direction on June 1, 1898. He not only had entire charge of the building of the airplane itself, but personally invented, designed, and constructed the 52-hp. five-cylinder gasoline engine, which was used on this large machine, the construction of this engine being completed in 1902. It weighed 125 lb., exclusive of cooling water, radiator and tanks, or at the rate of 2.2 lb. per hp. for the 52 hp., which it developed for 10 hr. continuously with a water absorption dynamometer. This was the first aviation engine in the world, as well as the first steel cylinder aviation engine.

Mr. Manly also had charge of all the research work that Dr. Langley carried on in the development of the airplane, including the first systematic tests ever made in determining the laws of the aerial screw propeller and the tests on the supporting power of curved surfaces and equilibrium control. Mr. Manly personally piloted the large Langley airplane during the tests made of it on Oct. 7 and Dec. 8, 1903, when it was in each case so damaged by catching on the launching gear that it was impossible to get a fair test of its ability when it got into the air.

After 1903 Mr. Manly devoted his time to developing some of his own inventions in power transmission, moving to New York in July, 1905. In 1915 he was consulting engineer to the British War Office, in connection with airplanes being built in this country, especially superintending the construction of the large 500-hp. twin-engine biplanes built at the Toronto factory of the Curtiss Aeroplane company.

From September, 1915, to the present date Mr. Manly has been consulting engineer to the Curtiss Aeroplane & Motor Corporation, Buffalo, N. Y., devoting his attention largely to the duties of chief inspection.

## B. B. BACHMAN

First Vice president Bachman was born Oct. 4, 1886, educated at grammar school, night school and under a

private tutor, and started his business experience in 1900 as a tracer. The next ten years were spent as tracer, detailer and designer with the Enterprise Mfg. Co. of Philadelphia, Falkenau Sinclair Machine Tool Co., Philadelphia, and the Autocar Co., Ardmore, Pa. His entire automobile experience has been with the last named company, which manufactured passenger vehicles until 1912 and commercial vehicles from 1907 to date. Starting with this company in February, 1905, he became assistant engineer in 1909 and engineer in 1914.

Mr. Bachman is now serving as chairman of the Standards Committee, in which capacity and as a Councilor he was of great value to the Society last year.

## E. H. BELDEN

Second Vice-president Belden, representing motor car engineering, is the chief engineer of the Willys-Overland Co., Toledo, Ohio. He was born on Dec. 23, 1868, at Jackson, Mich., and entered the employ of the McCormick Harvester Co. at the age of fourteen. After remaining with this company six years, he entered the employ of the Fort Wayne Electric Co., now the Fort Wayne Electric Works of the General Electric Co., in 1888. He invented the Belden arc lamp, which was manufactured at Fort Wayne, and subsequently disposed of the lamp to the Westinghouse Electric & Mfg. Co. in 1901. He remained with the Westinghouse company one year, and in 1905 formed the Belden Engineering Co., Pittsburgh, Pa., which designs automobiles. At the time of his election to the Society in 1913 he was president and engineer.

## ELMER A. SPERRY

Second Vice-president Sperry, representing aviation engineering, is numbered among the early builders of automobiles. He was born at Cortland, N. Y., Oct. 12, 1860, and received his technical education at Cornell University. In 1889 he became interested in the building of electric traction locomotives, and from 1892 to 1896 designed an electric street railway system that was sold to the General Electric Co. In 1894 Mr. Sperry engaged in the manufacture of storage batteries. His connection with the automotive industry dates from 1895, when he constructed a gasoline engine driven vehicle. In the years from 1896 to 1899 he built eighty electric automobiles which were sold direct to owners. In addition to this work, Mr. Sperry has built a number of internal-combustion engines and worked along many other branches of engineering. He is probably best known as the inventor of the gyroscope bearing his name and the organizer of the Sperry Gyroscope Co., Brooklyn, N. Y., of which he is president and engineer. Mr. Sperry is a charter member of the American Institute of Electrical Engineers and the American Electrochemical Society, and a life member of the American Society of Mechanical Engineers. He is also a member of the Society of Naval Architects and Marine Engineers, the U. S. Naval Institute, the American Physical Society, the American Chemical Society and the Franklin Institute. He has contributed numerous papers to the transactions of these societies. He became a Member of the Society in 1916, when the American Society of Aeronautic Engineers was merged with the S. A. E.



PRESIDENT CHARLES M. MANLY



T. B. FUNK



E. A. SPERRY



JOHN J. AMORY



CHARLES F. KETTERING



L. S. KEILHOLTZ



E. H. BELDEN



B. B. BACHMAN



J. V. WHITBECK



COKER F. CLARKSON



CHARLES S. CRAWFORD



DAVID BEECROFT



E. A. DE WATERS



DAVID FERGUSSON



C. B. WHITELSEY



E. A. JOHNSTON

## T. B. FUNK

Second Vice-president Funk, representing tractor engineering, was born April 8, 1878, at Larned, Kan. After being graduated from elementary and preparatory schools he acquired a technical education by private study and instruction and in night school. His connection with the automobile industry dates back to 1903. In 1911 he was appointed sales manager of the Marion Automobile Co., Indianapolis, Ind. In 1912 he was engaged in the design of a tractor, being general manager and engineer of the Universal Tractor Co., New Castle, Ind. Later he was general manager and engineer of the Universal Tractor Mfg. Co., Columbus, Ohio. Since 1915 he has been manager and chief engineer of the tractor department of the Moline Plow Co., Moline, Ill. He was elected a member of the Society Sept. 2, 1916. Mr. Funk was elected second vice-president, representing tractor engineering, to succeed Dent Parrett when the latter entered military service in 1918.

## JOHN J. AMORY

Second Vice-president Amory, representing marine engineering, was born at Fond-du-Lac, Wis., July 15, 1856. He has been connected with commercial enterprises practically all his life and has been with the Gas Engine & Power Co. and Charles L. Seabury & Co., Consolidated, Morris Heights, New York City, builders of motor boats, for over thirty years. At the present time he is president and general manager of this organization.

## L. S. KEILHOLTZ

Second Vice-president Keilholtz, representing stationary internal-combustion engineering, was born at Tiffin, Ohio, Dec. 22, 1883. He received his technical education at the Toledo Polytechnic School, from which he was graduated in 1903, and the Ohio State University, from which he received the degree of mechanical engineer in 1907. After being employed as gas engine tester by Fairbanks, Morse & Co., he went to the Thomas B. Jeffery Co., where he was engaged in the assembling, repairing and testing of cars. Later he was a draftsman at the plant of the National Cash Register Co., Dayton, Ohio, and chief draftsman of the Dayton Engineering Laboratories Co. He held the latter position until 1916, when he became chief engineer of the Domestic Engineering Co., specializing in lighting plants. He is a member of the American Society of Agricultural Engineers and of the National Gas Engine Association.

## CHARLES F. KETTERING

Past-president Kettering was born on a farm near Loudonville, Ohio, Aug. 29, 1876. He grew up amid the wholesome influences of farm life, and early in his career developed a determination to accomplish something worth while. The district school started him on his way. A term or two at high school and a session of summer normal work fitted him for teaching, and for a few terms he was in charge of the country school near his home.

Then he became connected with the Star Union Telephone Co., in the construction department. He left after a few months to enter the Ohio State University and was graduated in 1904 with the degrees of mechanical engineer and electrical engineer, and then went back to the telephone company and put into practice some of the knowledge he had acquired.

He was still in that position when E. A. Deeds got in touch with him and induced him to go with the National Cash Register Co., which at that time was in need of a

small motor to operate its electric cash registers. Mr. Kettering was selected for the task of designing the motor. The work he did is still in use practically in its original form on all electrically operated cash registers throughout the country.

Mr. Kettering was in charge of one of the invention departments of the National Cash Register Co. when the necessity for electrical equipment for automobiles impressed itself upon him. About eight years ago he developed his first generator system of ignition. The complete system of cranking, lighting and ignition quickly followed.

Mr. Kettering is, at present, president of the Dayton Engineering Laboratories Co., vice-president of the Domestic Engineering Co., manufacturer of electric lighting and power units for farm use, vice-president and consulting engineer of the Dayton Metal Products Co. and the Dayton-Wright Airplane Co.

In addition, Mr. Kettering has found time to devote to airplane development work, to which he has made some valuable contributions.

## E. A. DE WATERS

Councilor DeWaters was born July 22, 1874, at Kalamazoo, Mich., and was graduated from Kalamazoo College in 1899 with the degree of B.S. He received the same degree two years later from the University of Chicago. For two years he was engaged in testing engines for the Thomas Motor Car Co., Buffalo. In 1903 he went with the Cadillac Motor Co., Detroit, as layout draftsman. Later he was assistant superintendent of that plant, leaving there to go with the Buick Motor Co., Flint, Mich. Since that time he has been general foreman, layout man, assistant engineer and chief engineer. He was elected a Member of the Society in 1911.

## DAVID FERGUSON

Councilor Fergusson was born in 1869 at Bradford, Yorkshire, England. After completing his general education he took a three-years' course in mechanical engineering in the Bradford Technical College, being graduated therefrom in 1889. After being employed as a draftsman by various plants engaged in the building of locomotives and steam and internal-combustion engines, he entered the employ of the Leeds Forge Co. as a designer of pressed steel railroad stock. In 1893 he was engaged as a designer of steam and internal-combustion engines by Robey & Co., Lincoln, England. In 1897 he became chief draftsman with Bennington & Baines, London. In 1900 he came to New York, later taking a position as mechanical engineer and designer with E. C. Stearns, Syracuse, N. Y. He entered the employ of the George N. Pierce Co., Buffalo, as mechanical engineer and designer in 1901. He is now chief engineer of the Pierce-Arrow Motor Car Co., Buffalo. Mr. Fergusson was elected a Member of the Society in 1905.

## E. A. JOHNSTON

Councilor Johnston was born at Brockport, N. Y., March 1, 1875. He has been engaged as an engineer on tractors, motor trucks and stationary gas engines and been employed as engineer by the McCormick Harvesting Machine Co. and its successor the International Harvester Companies. At the present time he is manager of the experimental department of the last named.

## CHARLES S. CRAWFORD

Councilor Crawford is assistant general manager and chief engineer of the Premier Motor Corporation. He was born in Indianapolis, Ind., April 3, 1883, and at

## OFFICERS OF THE SOCIETY

149

tended grade schools in St. Louis. Saturdays and vacations were spent in serving an apprenticeship in foundry work, patternmaking, blacksmithing and machine shop practice in the Carondolet Foundry Co. He took an engineering course at the St. Louis Manual Training School of Washington University, being graduated in 1902.

He was employed in the pump repair department of the Dean Bros. Steam Pump Works. He spent nine months with the Big Four Railroad at Indianapolis in the installation of electric light equipment and in charge of locomotive inspection. Mr. Crawford served as chief draftsman on automobile gas engine and carburetor design at the Speed Changing Pulley Co., Indianapolis; also as draftsman in the experimental department of the Lozier Motor Works, Plattsburg, N. Y. He was chief engineer of the Speed Changing Pulley Co. and of the Cole Motor Car Co., Indianapolis.

Mr. Crawford is a member of the Electrical Equipment Division of the Standards Committee and was elected a Councilor in 1918. He was at one time chairman of the Indiana Section of the Society.

## J. V. WHITBECK

Councilor Whitbeck was born at Sodus, N. Y., May 28, 1882. He was employed as a draftsman and designer by the H. H. Franklin Mfg. Co. from September, 1904, to October, 1906, when he entered the employ of the Olds Motor Works as a designer. Leaving there in March, 1907, he accepted a similar position with E. R. Thomas, Buffalo, N. Y. In October of that year he was engaged as designer and checker by the United Spring Co., Buffalo. In 1908 he became designer, checker and experimental engineer with the Lozier Motor Car Co. He has been chief engineer of the Chandler Motor Car Co. since 1903.

## DAVID BEECROFT

Councilor Beecroft was born in the seventies at Mar-nock, Ont. In 1893 he taught a country school, prior to attendance at the Barrie Collegiate Institute. He was connected with the editorial department of a St. Thomas, Ont., daily newspaper. Leaving St. Thomas in the summer of 1901, he went with the *Chicago Daily News* as an advertising solicitor, remaining until December, 1902. During this period he was also Chicago correspondent for

two or three papers. In 1902 he became editor of the *Automobile Review*, Chicago, and then assistant editor of *Motor Age*.

Mr. Beecroft has served on the Council during the last three years. He has been a member of the Meetings Committee of the Society for two years, serving as chairman in 1918.

## CHARLES B. WHITTELSEY

Treasurer Whittelsey has been connected with the Hartford Rubber Works Co. since 1901, beginning as purchasing agent. In 1905 he was made assistant to the general manager, in 1906 superintendent, in 1911 secretary and factory manager, in 1915 vice-president and factory manager, and in 1916 president and factory manager. He was president of the Hartford Chamber of Commerce in 1914 and president of the Hartford County Manufacturers' Association in 1917.

Mr. Whittelsey is chairman of the Tire and Rim Division of the Standards Committee. He was a member of the Council of the Society in 1912 and 1913.

## COKER F. CLARKSON

Secretary and General Manager Clarkson was born in Des Moines, Iowa, 1870, and graduated from Phillips Exeter Academy in 1888. In 1889 he was in Government service in the Post Office Department. He was graduated from Harvard College in 1894, pursuing post-graduate work there for the next two years. He was next engaged in connection with the installation of an underground telephone system in Philadelphia for two years, after which he came to New York and spent several years in work on technical, legal, patent, laboratory and automobile subjects. From 1905 to 1910 he was connected with the Association of Licensed Automobile Manufacturers, as secretary of its Mechanical Branch, publicity manager and assistant general manager. During this time he was the editor of the A. L. A. M. Mechanical Branch Bulletins and of the A. L. A. M. weekly digest of current technical literature.

Mr. Clarkson has been secretary and general manager since 1910, first of the Society of Automobile Engineers and then of the Society of Automotive Engineers when the latter was formed.



# Standards Committee Meeting

**T**HE Standards Committee of the Society held a meeting on Feb. 4 to pass upon the work accomplished since the Semi-Annual Meeting held at Dayton last June. Chairman B. B. Bachman presided and consideration was given to thirty-one recommendations submitted by the Ball and Roller Bearings, Chain, Electrical Equipment, Engine, Miscellaneous, Springs, and Tire and Rim Divisions.

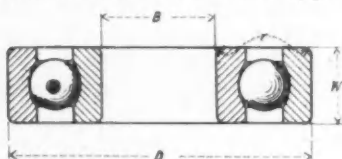
The reports as finally accepted by the Committee and reported to the meeting of the Society on the following day are given below, together with the discussion at the meeting of the Standards Committee.

These reports, having been approved by the Standards Committee, the Council and the Society at the Annual Meeting, are to be submitted to a letter ballot of the voting members before they are officially adopted as standards or recommended practices of the Society. The letter ballot for the mail vote of the members will be sent out in the near future.

## BALL AND ROLLER BEARINGS DIVISION

### (1) Annular Ball Bearings, Separable (Open) Type

The proposed sizes of separable (open) type bearings which are recommended as S. A. E. Standard are complete with the exception of the tolerances, which have yet to be decided. These bearings are extensively used in magneto construction and other small types of machines.



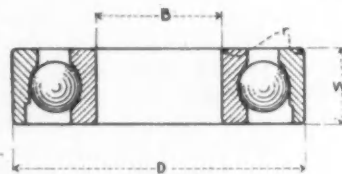
SEPARABLE (OPEN) TYPE OF ANNULAR BALL BEARING

No.	B		D		W OF INDIVIDUAL RINGS		F CORNER RADIUS	
	Mm.	Inches	Mm.	Inches	Mm.	Inches	Mm.	Inches
5	5	0.19685	16	0.62992	5	0.19685	0.2	0.008
6	6	0.23622	21	0.82677	7	0.27559	0.3	0.012
7	7	0.27559	22	0.86614	7	0.27559	0.3	0.012
8	8	0.31496	24	0.94488	7	0.27559	0.3	0.012
9	9	0.35433	28	1.10236	8	0.31496	0.3	0.012
10	10	0.39370	28	1.10236	8	0.31496	0.3	0.012
11	11	0.43307	32	1.25984	7	0.27559	0.4	0.016
12	12	0.47244	32	1.25984	7	0.27559	0.4	0.016
13	13	0.51181	30	1.18110	7	0.27559	0.3	0.012
14	14	0.55118	35	1.37795	8	0.31496	0.5	0.020
15	15	0.59055	35	1.37795	8	0.31496	0.5	0.020
16	16	0.62992	38	1.49607	10	0.39370	1.0	0.040
17	17	0.66929	44	1.73229	11	0.43307	1.0	0.040
18	18	0.70866	40	1.57481	9	0.35433	1.0	0.040
19	19	0.74803	40	1.57481	9	0.35433	1.0	0.040

NOTE.—For temperature of measurement and definition of eccentricity, see S. A. E. Handbook, vol. I, page 20ca.

### (2) Annular Ball Bearings, Extra Small Series

This series, which is recommended as an S. A. E. Standard, is complete with the exception of all tolerances,



EXTRA SMALL SERIES OF ANNULAR BALL BEARING

which have yet to be decided. It is intended for use in airplane sheave pulleys and special apparatus.

No.	B		D		W OF INDIVIDUAL RINGS		F CORNER RADIUS	
	Mm.	Inches	Mm.	Inches	Mm.	Inches	Mm.	Inches
9430	4	0.15748	16	0.62992	5	0.19685	0.5	0.02
9431	5	0.19685	19	0.74803	6	0.23622	0.5	0.02
9432	6	0.23622	19	0.74803	6	0.23622	0.8	0.03
9433	7	0.27559	22	0.86614	7	0.27559	0.8	0.03
9434	8	0.31496	22	0.86614	7	0.27559	0.8	0.03
9435	9	0.35433	26	1.02363	8	0.31496	0.8	0.03

NOTE.—For temperature of measurement and definition of eccentricity, see S. A. E. Handbook, vol. I, page 20ca.

### (3) Angular Contact Ball Bearings

The Division recommends that the following paragraph be printed in the Handbook, instead of duplicating the tables already printed for the regular Annular Ball Bearings.

"Ball bearings of the angular contact type are identical in sizes and boundary dimensions with S. A. E. Standard Annular Ball Bearings in the Light, Medium and Heavy Series as printed on pages 29, 29a and 29b, S. A. E. Handbook, vol. I."

In presenting the report of the Division, F. G. Hughes, chairman, said that the series of separable (open) type bearings had been known to the members in the past as magneto bearings, which found their first use in magneto and similar small electric apparatus not only in this country but abroad. The list of bearings showed a rather logical progression as to bore sizes, but not quite so much for the progression of outside diameters. The only plea that could be put forward for the list as it now stood was that it had met almost universal practice not only here but abroad for the purpose for which these bearings were intended. So many hundreds and possibly millions of these bearings are out and constantly being manufactured to these dimensions that it would seem almost impossible to throw them out and standardize a series of bearings not required where this present list apparently meets all requirements.

## CHAIN DIVISION

### (4) Roller Chain Nomenclature

The Chain Division, which has been working jointly with the A. S. M. E. Committee, recommends changing the standard roller chain designation from "Universal No." to "Manufacturer's Standard No." This change will be incorporated in the present S. A. E. Recommended Practice for Roller Chain Dimensions as given on page 14c, S. A. E. Handbook, vol. I.

Manufacturers' Standard No.	Pitch	*Chain Width	Roller Diameter
2	1/2	1/4	0.306
2 1/2	5/8	5/8	0.400
3	3/4	1/2	1 1/2
4	1	3/4	5/8
5	1 1/4	1	1 1/4
6	1 1/2	1	1 1/4
7	1 3/4	1	1
8	2	1 1/4	1 1/4
10	2 1/2	1 1/4	1 1/4

Dimensions are in inches.

\*Distance between the inside plates.

## STANDARDS COMMITTEE MEETING

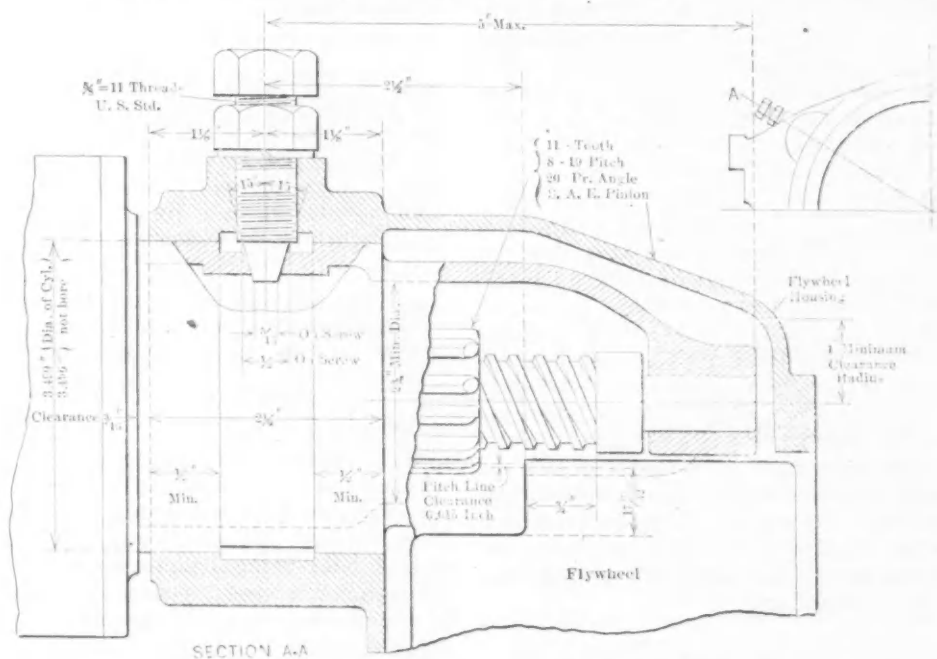
151

## ELECTRICAL EQUIPMENT DIVISION

### (5) Sleeve-Type Starting Motor Mounting

The sleeve or cylindrical type of starting motor mounting has come into more or less general use, and the Division recommends the accompanying drawing for adoption as S. A. E. Recommended Practice. It is the opinion of the Division that this mounting should be used only for outboard mesh installations, as it is not considered a suitable type for inboard constructions. The mounting consists of a cylindrical portion of the gearshift hous-

reconsidered because of difference in opinions regarding its specification. The industries have again been circularized and as a result the Division recommends that when it is desired to use a non-magnetic shim with magnetos mounted on cast-iron pads, the shims shall be  $\frac{1}{2}$  in. thick, and high-strength bronze bolts used. The thickness of the shim shall be added to the dimension N on the drawing, data sheet 36, S. A. E. Handbook, vol. I, when laying out the distance from the face of the mounting pad to the center of the magneto shaft. It is suggested that a grid construction be used for the shims.



### SLEEVE OR CYLINDER TYPE OF STARTING MOTOR MOUNTING

ing sliding into a bored hole in the bell-housing, the length of which is about two-thirds the diameter of the bore. The motor is locked in position by a screw through the bell housing entering a tapered hole in the cylindrical portion of the gearshift housing. This mounting is for use with the standard eleven-tooth pinion assembly.

## THE DISCUSSION

R. J. BROEGE: Is the location of the gear on the fly-wheel given in the same relation from the flange as with the other two pads?

W. A. CHRYST: This, having no flange, wipes that out.

MR. BROEGE: What I was thinking of was that some crankcases might be fitted with the old flange and this type of mounting could be used.

MR. CHRYST: If you compare the types, you see it would not be possible to bolt on an old flange if you use this type of mounting. This type was specified for cases where it is impossible to use the flange and in which there would be no advantage in making allowance for its use.

MR. BROEGE: This is preferable to the other mountings, but where crankcases are fitted with the other flange, you could not apply this starter mounting.

MR. CHRYST: By the use of an adapter I think this could be put in very easily.

#### (6) *Non-Magnetic Magneto Shims*

This subject was considered last year, but has been

(7) *Magneto Couplings—Flexible Disk*

After carefully considering the data accumulated on this subject, the Division has made the following recommendation to cover flexible disk couplings for all magneto drives, including impulse type, and generators.

Outside diameter of disk,  $2\frac{3}{4}$  in.

Inside diameter of disk, 1 in.

Diameter of bolt circle, 2 in.

Thickness of disk,  $\frac{1}{4}$  in.

Number of 1/4-in. bolts equally spaced, 4.

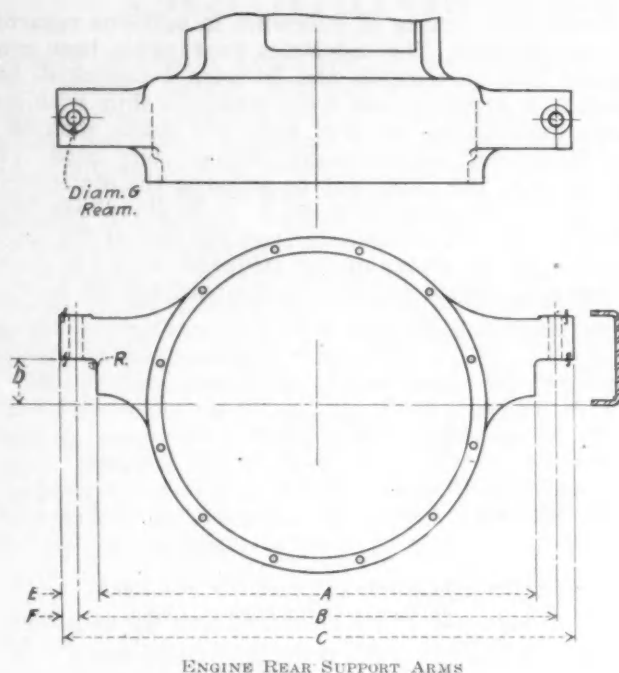
This recommendation, together with the driving shaft-end coupling dimensions, printed on pages 36 and 36xa, S. A. E. Handbook, vol. I, completes the S. A. E. Standard for magneto disk couplings.

## ENGINE DIVISION

### (8) Engine Support Arms for Trucks Only

The Engine Division recommends engine rear support arms in two sizes, the large size for the No. 1 S. A. E. flywheel housing and the small size for the Nos. 2, 3 and 4 S. A. E. flywheel housings. Further standardization to include the front rocker bearing is being considered by the Division, and if it seems desirable to standardize this part of the mounting a recommendation will be made at a later date.

S. A. E. Flywheel Housing	A	B	C	D	E	F	G	R
No. 1.....	23½	26¾	28¾	2	2½	1	0.750	⅝
Nos. 2, 3 and 4...	23¾	24¾	25¾	2½	1½	¾	0.625	¾

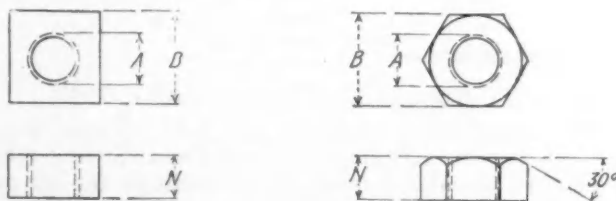


ENGINE REAR SUPPORT ARMS

## MISCELLANEOUS DIVISION

## (9) Nuts for Machine Screws

In the past machine screw nuts have varied greatly in proportions. After long consideration the Miscellaneous Division, in cooperation with the A. S. M. E. Committee and the machine screw nut manufacturers, recommends the following machine screw nut sizes and proportions for adoption as S. A. E. Standard.



NUTS FOR MACHINE SCREWS

SIZE A		Short Diameter (B)	Nominal Thickness (N)
No.	Decimal		
0†	0.060	$\frac{1}{16}$	0.045
1†	0.073	$\frac{3}{32}$	0.055
2	0.086	$\frac{1}{8}$	0.065
3	0.099	$\frac{5}{32}$ ‡	0.074‡
4	0.112	$\frac{3}{16}$	0.084
5	0.125	$\frac{7}{32}$ ‡	0.094‡
6	0.138	$\frac{1}{2}$	0.104
8	0.164	$\frac{11}{32}$	$\frac{1}{4}$
10	0.190	$\frac{3}{8}$	$\frac{9}{64}$
12	0.216	$\frac{7}{16}$	$\frac{5}{32}$
14	0.242	$\frac{1}{2}$	$\frac{3}{16}$
18	0.294	$\frac{9}{16}$	$\frac{1}{2}$
20	0.320	$\frac{11}{16}$	$\frac{1}{2}$
24	0.372	$\frac{11}{8}$	$\frac{3}{4}$
30	0.450	$\frac{25}{16}$	$\frac{3}{4}$

Notes.—\*Intermediate sizes are special—7, 9, 16, 22, 26, 28. Their dimensions are the same as for—6, 8, 14, 20, 24, 24. †Made from bar stock only.

‡Unless made from bar stock, Nos. 3 and 5 will be made the same dimensions as Nos. 2 and 4 respectively. Table gives all stock sizes for square and hexagon machine screw nuts of brass, iron and steel.

In presenting the report on this subject, E. H. Ehrman, chairman of the Division, said. "The only suggestion I have to offer in connection with the specifications is that, in view of the possible time that the number sizes of screws will stop at No. 12, the numbers larger than 12 would be replaced by fractional sizes;  $\frac{1}{4}$  in. for No. 14,  $\frac{5}{16}$  in. for No. 20,  $\frac{3}{8}$  in. for No. 24, and  $\frac{7}{8}$  in. for No. 30. This will in no way affect the outside dimensions of the nut, and it is brought to your attention merely to avoid any misunderstanding or confusion in case any later Division action may eliminate the decimal sizes of above No. 12.

## THE DISCUSSION

E. H. EHRMAN: In the first place, nuts for machine screws are usually punched, have rough exterior, and are not very accurately made; the holes are not counter-sunk but only tapped, leaving the partial threads unfinished at each side of the nut. Moreover, this specification has been adopted in toto by all of the machine screw nut manufacturers, and satisfies the requirements originally laid down by the Navy, which are:

That the tap size of the nut should be easily distinguishable by the outside dimensions, which means that no two tap sizes should have the same outside dimensions.

That especially in the larger sizes the dimensions of the nuts should require no new wrench sizes.

With reference to the aeronautic S. A. E. standards, which were adopted approximately a year ago, I would say that the nuts, according to the standard, are made from the bar; the specification calls for both ends of the tapped hole being counter-sunk, which might remove, through carelessness, more thread than is intended. That is one reason why the thickness of the nut was made approximately 0.01 in. more in the case of the No. 4 nut.

On the other hand, at the meeting of the Aeronautic Division that had the formulation of this specification in hand, it was decided that  $\frac{3}{32}$  in. should be the thinnest nut, and also the thinnest head; also that the next size above No. 4 should have a thickness that would be proportionate to the size, based on the No. 4 and the nut size above it. This made it necessary to make the thickness of the nut 0.109 in. You will see that the aeronautic nut specification was rather tied up to earlier specifications formulated by the Aeronautic Division.

On the other hand, I see no real need for trying to co-ordinate the two. Each one serves its purpose. There is going to be no confusion whatever. A machine screw nut is made with such large tolerances and width limits, that it would be unsuitable for aircraft work.

Another feature that enters into the specification for the aircraft series is that of reducing the number of wrench openings to a minimum. Consequently, not alone in the two sizes mentioned is the short diameter made the same, but also in some of the larger sizes, No. 12 and  $\frac{1}{4}$ -in.

I do not see any reason why both standards should not stand and be adopted by the Society. Further than this, the Aeronautic Division has deviated from the automobile specification in making the thickness of the nut three-quarters of the diameter, rather than seven-eighths and has also instituted a thin series of nuts. I do not see anything whatever in the two specifications that conflicts on account of the difference in use of the nuts.

It remains to be said, however, that inasmuch as the machine screw nut specification has been adopted by the nut manufacturers, it seems hardly wise to make any

changes in it. If it is not acceptable to the Society, it will have to be rejected in toto, as it is hardly subject to amendment.

MR. W. HANKS: The fact that the aeronautic standards that the Society adopted have been adopted by both the Army and the Navy gives them considerable strength, I hardly think that either the Army or the Navy will feel like changing those standards. It was found advisable, after a long series of tests made about a year ago, to make the aircraft nuts a different standard than was formerly adopted by the Society, because of the classes of steel being used. That was accepted by both the Army and Navy. All their orders are going through with those particular nuts, and they are averse to making any changes.

CHAIRMAN BACHMAN: It is my understanding that this recommendation of the Miscellaneous Division is not a change from the aeronautic standard. This refers distinctly to nuts for machine screws. The thing Mr. Hanks is talking about is plain nuts for aeronautic practice.

MR. HANKS: Quite true. But I see no reason why the standards should not be the same.

MR. EHRMAN: I would like to add that the difference between the standards for aeronautic bolts, and the automobile standards in which the nuts are thicker, is on account of high-tensile steel used in aeronautic practice. Consequently, for the sake of lightness, the heads are made thinner on the aeronautic bolts. In a test made at the Curtiss plant it was found that a nut having a thickness of three-quarters diameter was equal in strength to a heat-treated nickel-steel bolt. So that there is no need of having it thicker. The aeronautic thin nut is a finished product. A machine screw nut is a very rough product that can be easily distinguished, and probably would not be used in aeronautic practice at all.

MR. HANKS: It so happens that there are only three sizes. If the series is right, why should they not be put out in other sizes? Another point occurs to me. Why is it the Society adopts an S. A. E. Standard here for these particular sizes, while it has not previously adopted S. A. E. sizes above  $\frac{1}{4}$ -in.?

CHAIRMAN BACHMAN: I think the answer is that below  $\frac{1}{4}$ -in. the S. A. E. Standard is the A. S. M. E. machine screw thread.

MR. EHRMAN: The aeronautic standard stands by itself. The pitches are not in all cases A. S. M. E., and, more than that, the question of ability to get on the market thirty-seven sizes of stock, made the Committee apprehensive; so instead of what they should have done, they have deviated from that to get sizes that they thought would be commercially obtainable on the market. Instead of the machine screw nuts being compromised, the aeronautic standard was compromised. Further than that, you are not adopting an A. S. M. E. specification; this recommendation is from a joint committee composed of A. S. M. E. and S. A. E. members. Each society can adopt the recommendations of the committee without adopting a standard of the other society.

MR. HANKS: May I ask, Mr. Ehrman, if in the work of the National Screw Thread Commission, there is a tendency to confine ultimate U. S. standard pitches to S. A. E. standard pitches above  $\frac{1}{4}$  in., leaving out the A. S. M. E. sizes above  $\frac{1}{4}$  in.?

MR. EHRMAN: The trend is to abolish number sizes above No. 12, so that ordinary machine screw nuts above No. 12 in size would be made in fractional sizes, to obviate duplications of sizes approximating each other.

MR. HANKS: Anticipating that possible decision, we are standardizing in a series of A. S. M. E.  $\frac{1}{4}$  in. If the outside dimensions of the aeronautic and the machine screw nuts corresponded, it would be all right.

MR. EHRMAN: The machine screw nut dimensions recommended by the Division correspond to from 85 to 90 per cent of the machine screw nuts made in the industry today. This specification is merely a formal presentation of the best practice that has obtained for years.

W. S. HOWARD: I would like to know why, when we make up these tables, we cannot have the long dimensions of the nut included, either in decimals or in the nearest fraction.

MR. EHRMAN: I think that there should be tables among the data sheets, giving the long diameters for different sizes of hexagon and square nuts.

MR. HOWARD: Before we can establish the bolt clearance diameter, we must know the long diameters.

MR. EHRMAN: There is a danger in putting in that specification because users will complain that the long diameters are not as represented. For computation and designs a table among the data sheets that gives that information would be more desirable. The long diameters are in a way necessary in Europe, particularly in France, for the reason that the bolts are made out of round stock, and the heads are square, so that it is a matter of necessity to know what stock is to be used, but in this country where the long diameters cut no figure in manufacture and the only figure that they cut is in design, we could obtain the information from one table rather than go through all bolt and screw specifications to obtain what we wish. There is no objection whatever to putting it in a separate table with an explanatory note.

#### (10) Spark-Plug Dimensions—Aeronautic

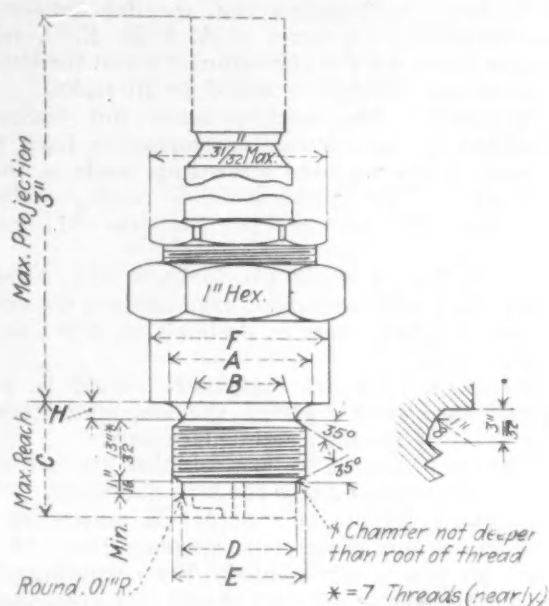
The extension and revision of aeronautic spark-plug shell dimensions, printed on pages 3a and 3b, S. A. E. Handbook, vol I, has been considered by the Division, with a view to bringing the present S. A. E. Recommended Practice into harmony with a desired international standard.

In presenting a verbal report on this subject Mr. Ehrman said that this shell follows very closely the recommendations of the British Engineering Standards Association, with the exception of a few changes in the maximum projection, which was reduced from  $3\frac{1}{2}$  to 3 in.; the length of the thread, which was changed from  $21/64$  to  $13/32$  in., and the note at the right, which was changed from five threads to seven threads nearly. These will in no way bar use of the spark-plug in British engines; in fact the Division is in receipt of a letter from Rolls-Royce, Ltd., in which the statement is made that it prefers a cylinder-wall thickness of 0.6 in. to a wall thickness of 0.5 in. This, together with the fact that 0.6 in. meets the Liberty engine dimensions, as well as those of other American makes of engine, influenced the making of these changes. Also, it was found that the spark-plugs used on a large number of American engines corresponded to the plugs having dimensions as revised.

#### THE DISCUSSION

C. C. HINKLEY: I would like to ask Mr. Ehrman's opinion on the amount of space he has allowed to bend the wire at the bottom of the plug. He states that the  $23/64$ -in. dimension should be increased. That cuts the wire down.

MR. EHRMAN: The diagram merely shows an optional



\* Not specified by Anglo-American Committee

AERONAUTIC SPARK PLUG SHELL

way of using that space. This is not the best construction or the preferred construction, and our changes were made in strict accordance with the preferred construction; also so as not to interfere with the British specifications. The British will not make use of the petticoat below the thread; they do not like it. In this country we prefer it. The British will mount the electrode as though there were no petticoat there, whereas we would extend the petticoat to the distance shown; and the one electrode will be a pin running across the diameter, and passing through the petticoat. The recommendations fit both the British requirements, and the best we can find with reference to American requirements.

MR. HINKLEY: In aeronautical plug practice is it proper to use the wire plug base?

MR. EHRMAN: Our suggestion permits it.

MR. HINKLEY: The idea being that it is permissible in our construction to make that distance greater in the wire if we wish?

MR. EHRMAN: Yes.

H. M. CRANE: The screw thread terminal recommended by the Division is certainly not common.

CHAIRMAN BACHMAN: Is there any objection to having it as an option?

MR. CRANE: I do not know that there is any objection. We do want some type of snap terminal, without a doubt.

MR. EHRMAN: There are no dimensions on the fastening device other than the 8-32 A. S. M. E. thread, so that if the thread is not to be used, the shape of the terminal could be modified as desired; or the matter might be further considered by the Division as to standardizing the terminal for use in this country.

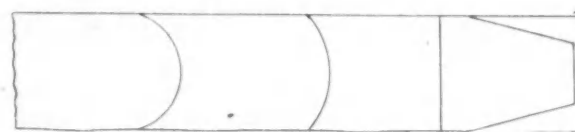
CHAIRMAN BACHMAN: Would it materially affect the proposition, if all reference to the terminal end were left off? That is, would the action you are desiring to take be accomplished if that were left off?

MR. EHRMAN: Yes.

#### SPRINGS DIVISION

##### (11) Leaf Points—Nomenclature

Many of the leaf points shown on page 49b, S. A. E. Handbook, vol. I, are obsolete. The Springs Division



No. 1 Round No. 2 Half Round No. 3 Square No. 4 Blunt Diamond  
LEAF POINT NOMENCLATURE

has therefore prepared the accompanying series of leaf points as answering all commercial requirements, and recommends that the nomenclature indicated be adopted as S. A. E. Standard.

##### (12) Leaf Points

The following leaf points shown above are recommended by the Springs Division for adoption as S. A. E. Recommended Practice:

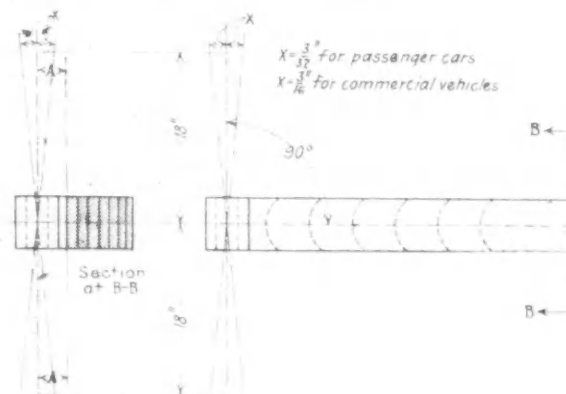
Leaf Points Nos. 1, 2 and 3 for rolled tapered leaves

Leaf Points Nos. 3 and 4 for full thickness leaves

Rebound clips to be used in all cases

##### (13) Test for Parallelism

The present 3/16-in. value for angular variation of the eye center line is considered too close for practical commercial vehicle spring tests and the Division recommends that this be specified as 3/8 in. both ways for commercial vehicles as shown in the accompanying drawing.



TEST FOR PARALLELISM

##### (14) Eye Bushings and Bolt Tolerances

The tolerances shown on page 49d, S. A. E. Handbook, vol. 1, are considered too close for practical application. The Springs Division recommends that they be opened up to within commercial limits as follows:

Bushed eyes—plus 0.001, minus 0.003

Bolts for bushed eyes—minus 0.005, minus 0.008

Unbushed eyes—plus 0.001, minus 0.004

Ground bolts for unbushed eyes—minus 0.006, minus 0.009

Unground bolts (hot-rolled) for unbushed eyes—diameter minus 0.006, for maximum so as to use standard reamers

In presenting this report, Walter M. Newkirk, chairman of the Division, called attention to the fact that the standard deviation is used with reference to the distance that the eye center line is from a line at right angles to the spring center line at a distance of 18 in. from the spring instead of the total or twice this distance. This tolerance has been doubled in the case of commercial vehicles, principally for the reason that it is practically impossible to attain that degree of accuracy heretofore specified in this class of work.

## STANDARDS COMMITTEE MEETING

155

Supplementing this report on S. A. E. Recommended Practice, Mr. Newkirk said that all of the changes were made with the idea of permitting the use of standard recommended articles which can be bought on the market. The finished sizes of bolts, when they are ground, can, of course, be made just as readily from one range as they can from another.

(15) *Wrapped Eyes*

The Division recommends that the S. A. E. Recommended Practice on page 49e, S. A. E. Handbook, vol. I, be changed to read: "Where drive is taken through springs on commercial vehicles, the second plate may be loosely wrapped around the eye of the driving end. In all other cases wrapped eyes should not be used."

(16) *Width of Spring Ends*

It is recommended by the Division that the tolerance for spring widths be changed to 0.005 in. for passenger cars and 0.010 in. for commercial vehicles. The revised S. A. E. Recommended Practice will read, "Spring ends should be finished to a width of 1/16 in. less than the nominal width of the springs, with a plus or minus tolerance of 0.005 in. for passenger cars and 0.010 in. for commercial vehicles, to a point far enough back on the spring to allow free shackle movement or free sliding movement in case of flat-end springs."

(17) *Rebound Clips, Spacers and Bolts*

It is recommended that the following note be added to page 49u, S. A. E. Handbook, vol. I: "Clearance between the rebound clip bolts (or spacer tubes if used) and spring plates shall not exceed 3/32 in. for passenger cars or 3/16 in. for commercial vehicles."

(18) *Spring Widths, Lengths, Eye and Clip Diameters for Commercial Vehicles*

It is recommended by the Division that page 49h, S. A. E. Handbook, vol. I, be revised so that in the third line of the first paragraph the expression, "1/4 in. larger," will read, "the same," and the following added at the end of the paragraph: ". . . as on the other end, and in agreement with the above table. Considering strength of the main plate, it is believed more desirable to put a heavier load on a bushing than to risk opening up the eye, which might happen if the eye were increased in diameter."

Capacity, Tons	Loca- tion	Approx. Load per Spring, Lb. (Truck Loaded)	Spring Width, (In.)	Min. Length of Spring, In.	Eye Diam. (See Notes)	Spring Clip Diam. (Alloy Steel)	
						Spring Set on Axle	Spring Under- slung
3/4	Front Rear	To be determined	2 or 2 1/4 2 or 2 1/4	40 50	3/8 7/8	5/8 3/4	3/4 3/4
1	Front Rear		2 or 2 1/4 2 1/4 or 2 1/2	40 50	3/8 1	5/8 3/4	3/4 3/8
1 1/2	Front Rear		2 1/4 or 2 1/2 3	42 54	3/8 1	3/4 7/8	7/8 1
2	Front Rear		2 1/4 or 2 1/2 2 1/2 or 3	42 54	3/8 1 1/8	3/4 7/8	7/8 1
4 1/2	Front Rear		2 1/2 or 3 3 or 4	44 56	7/8 1 1/4	7/8 1	1 1 1/8
5	Front Rear		3 4 or 5	44 56	7/8 1 1/4 or flat end	7/8 1	1 1 1/8
7	Front Rear		3 5	46 58	1 1 1/4 or flat end	1 1 1/8	1 1/8 1 1/4

NOTES—The column "Capacity, Tons," is intended only to indicate the general truck capacities on which the corresponding usual spring sizes are used. The above table applies to all types of drives.

Heat-treated alloy steel spring clips shall be used in all cases.

In presenting these two recommendations for acceptance as S. A. E. Recommended Practice, Mr. Newkirk stated that the approximate load per spring had been omitted since the Division felt that it had not sufficient information to state properly what these loads should be. It was also felt that it was desirable to give optional widths of certain of the springs for both classes of vehicles.

(19) *Spring Widths and Lengths, Eye and Clip Diameters for Passenger Cars*

The data in the tables of spring widths, eye and clip diameters for passenger cars and commercial vehicles have been carefully reviewed and revised by the Division in order to have them accord with current practice. The figures relative to spring lengths are added to the tables, as it is believed they will be of value to car designers.

Shipping Weight of Car, Lb.	Location	Approx. Load per Spring (With Passen- gers), Lb.	Recom- mended Spring Length, In.	Spring Width, In.	Eye Diameter (See Notes)	Spring Clip Diameter, In. (Alloy Steel)
Under 2500	Front	To be determined	38	1 3/4	5/8	1 1/2
	Rear		52	1 3/4 or 2	5/8	1 1/2
2500 to 3000	Front		40	1 3/4 or 2	5/8	5/8
	Rear		54	2 or 2 1/4	5/8	5/8
3000 to 3600	Front		40	2	5/8	5/8
	Rear		56	2 or 2 1/4	5/8	5/8
3600 to 4200	Front		42	2 or 2 1/4	3/4	5/8
	Rear		58	2 1/4 or 2 1/2	3/4	1 1/8

The third sentence of the notes in the data sheet should be omitted and the following note added, "Heat-treated alloy steel spring clips shall be used in all cases."

(20) *Frame Brackets*

It is recommended by the Division that the third paragraph of this subject on page 49e, S. A. E. Handbook, vol. I, be extended to read, "The distance between the ears of bracket hoods should be 0.010 in. greater than the finished width of the spring eyes, with a minus tolerance of 0.000 in. and a plus tolerance of 0.005 in. for passenger cars. For commercial vehicles the minus tolerance should be 0.000 in. and the plus 0.010 in.," thus making the S. A. E. Recommended Practice cover both classes of vehicles.

(21) *Leaf Spring Specifications*

In connection with item (f) on page 49i, S. A. E. Handbook, vol. I, the following revision is recommended for the S. A. E. Standard "Method of clamping spring in center."

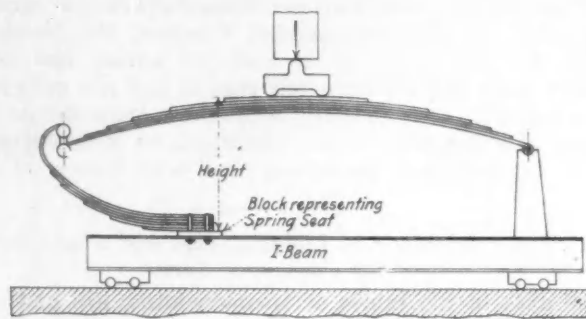
Bolt ..... (S. A. E. Standard)  
Nibs ..... (Not recommended)  
Band ..... (Not recommended)  
Spring seat lengths over all .....  
Distance between spring clips .....

It is recommended by the Division that the item (g) on page 49i, S. A. E. Handbook, vol. I, be revised in part to read, "Fill in type of eye as follows, 'In,' 'Out.'"



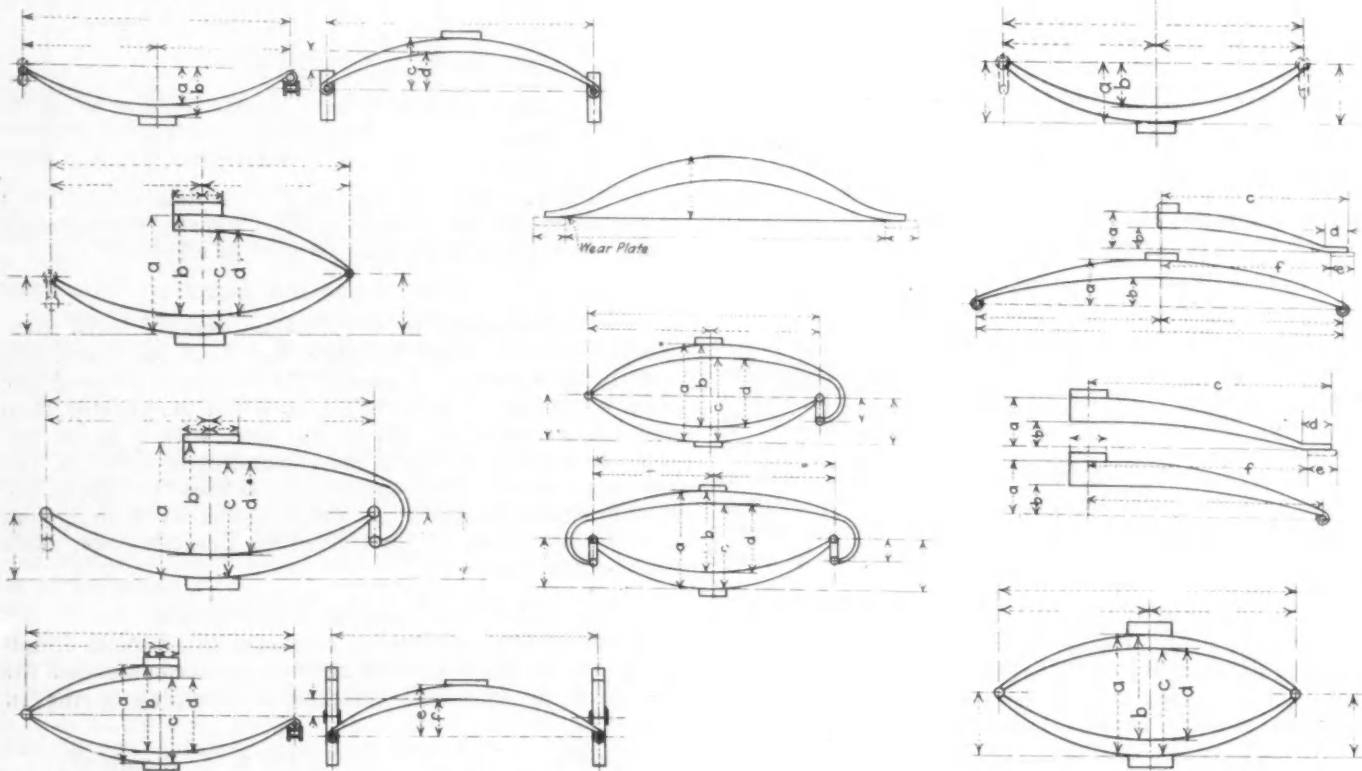
TYPES OF SPRING EYES

It is also recommended that the illustration be changed to show the words "In" and "Out" as shown in the drawing.



THREE-QUARTER ELLIPTIC SPRING COMPRESSION-TEST SUPPORT

The Division recommends that the group of drawings on page 155 be revised to show the position and in some cases the length of the spring seats. On page 49q, S. A. E. Handbook, vol. I, the drawing is wrong and should be as shown in the accompanying drawing, the rollers being under the I-beam instead of under the end of the spring.



LEAF SPRING SPECIFICATIONS

(22) *Finishes of Springs*

The Division recommended that only three finishes be adopted as S. A. E. Standard, since only that number are really accepted as standard by the trade. These are as follows:

**Black**—All plates left in the condition in which they left the heat-treating process

**Half Bright**—Outside surface of the eyes, and the upper exposed portion of the plates to be ground or polished, free from scale. Remaining exposed surfaces to be left black

**Bright**—To be the same finish as half bright, with the addition that the edges of all plates are to be ground or polished

## TIRE AND RIM DIVISION

(23) *Industrial Truck Tires*

It was found upon investigation that there is little uniformity in present practice for industrial truck tire sizes. After carefully considering the situation the Tire and Rim Division recommends that the following industrial truck tire and wheel dimensions be adopted for S. A. E. Standard:

TIRE DIMENSIONS		WHEEL DIMENSIONS	
Nominal Diameter, In.	Sectional Widths, In.	Wheel Diameter, In.	Widths of Felloes, In.
10	3½	6	2¾
10	5	6	4¼
16	3½	12	2¾
16	5	12	4¼
20	3½	16	2¾
20	5	16	4¼
24	3½	20	2¾
28	3½	24	2¾

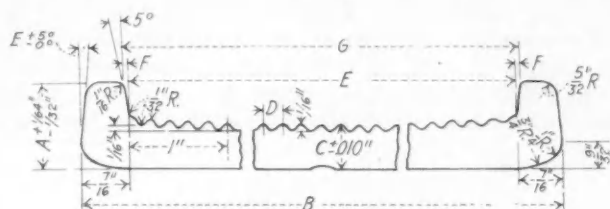
"Wheel diameters shall be 4 in. less than the nominal tire diameters. The height of the finished tire is to be 2 in. for all sizes. The width of the wheel felloe is to be in accordance with the present S. A. E. standard truck tire practice and the rim diameter tolerances will be plus 0.005, minus zero." The acceptance of this recommendation will make all the former or present S. A. E. standards for industrial truck tire sizes null and void.

(24) *Base Bands for Solid Tires*

The base band dimensions recommended for S. A. E. Standard are shown below. These conform to the recommended series of solid tire sizes and are in accordance with the base bands recommended and adopted by

## STANDARDS COMMITTEE MEETING

157



BASE BANDS FOR SOLID TIRES

the War Service Committee of the Rubber Industry of the U. S. A. The recommended bands relate to corrugated mill sections and it is optional with tire manufacturers to use either mill corrugated or dovetail facings, as the same general dimensions apply to bands with either facing.

BASE BANDS FOR SOLID TIRES

Base Band Size	A	B	Limits of B	C	CORRUGATIONS		E	G	F
					No.	D			
3½	¾	4¼	± 1/32	11/32	18	0.191	37/64	37/64	1/16
4	25/32	4 13/16	± 1/32	3/8	20	0.196	35/64	41/64	3/32
5	27/32	5 5/8	± 1/32	7/16	26	0.189	45/64	51/64	3/16
6	27/32	6 7/8	± 1/32	7/16	32	0.185	55/64	61/64	3/16
7	27/32	7 7/8	± 1/32	7/16	36	0.192	65/64	71/64	3/16
8	¾	8 ¾	± 1/32	7/16	40	0.196	75/64	81/64	3/16
10	¾	10 ¾	± 1/32	7/16	50	0.196	95/64	101/64	3/16
12	¾	12 ¾	± 1/32	7/16	60	0.197	115/64	121/64	3/16
14	¾	14 ¾	± 1/32	7/16	70	0.197	135/64	141/64	3/16

## THE DISCUSSION

J. E. HALE: I believe we should have a standard which will ultimately be one thing or the other, and that we will make a mistake if we adopt a standard which makes corrugated or dovetail facings optional on base bands. Furthermore, there is a detail in dimension on the base band that I would like to see changed; the curve at the lower corner, on the under side, does not provide the most effective lead for pressing on the tires. Eliminate the 1/4-in. radius altogether. I would like to see the recommendation of the Division on base bands changed to read that the S. A. E. Standard base shall be corrugated, and that that particular detail in connection with the dimension of the band should be changed as first specified by me.

C. B. WHITTELSEY: Relative to the first point that Mr. Hale brings out, to get all these bands corrugated and leave out the dovetail, I think that would work a hardship on a number of solid tire manufacturers, and could not be carried through successfully. It would limit the design there, which has been worked successfully since the first base bands were made.

MR. HALE: This base band standard has been the subject of very thorough deliberation by the War Service Committee of the Rubber Industry, and it was definitely understood that the ultimate standard would be a corrugated base. It was admitted that there might be some manufacturers who would want to use a dovetail base until they had worked out some improvements. But bear in mind the big idea of a base standard was to have one standard, so as to simplify production. We shall not accomplish what we should, if we have a dual standard. The understanding in the Rubber Committee was that anybody who wanted to use the dovetail for the time

being was to have this privilege, but that the ultimate standard was to be a corrugated standard.

J. G. SWAIN: I was secretary of the Solid Tire Committee of the Rubber Industry that considered this subject, and it was the consensus of opinion of the Committee that the solid tire manufacturers were not in a position at this time to recommend a definite form of corrugation or facing for a base band, and the minutes of the meeting and the records of the various meetings of the Committee will show that they were not ready to adopt a definite standard. The matter was left open as optional, and I am sure that that is the position that the majority of the solid tire manufacturers take on the way this subject should be handled. Furthermore, I think that it is really beyond the functions of this Society to adopt a standard here without it having been recommended by the industry, which is so vitally interested in the subject, and I think that the matter should be left as recommended right here in this report. If at any time the solid tire manufacturers are ready to recommend a definite standard as to the facing of the base band for a solid tire, they will submit that to the proper committee of this Society, with the request that it be adopted.

W. N. DUNCAN: I also was on the War Service Committee and think that Mr. Hale's opinion is incorrect regarding this facing.

W. M. BRITTON: I believe the Society should not take the position of deciding definitely on the particular kind of facing that should be used on the base band. I believe that should be left to the particular user of the band, or the tire manufacturer. I believe, however, that it would be a step in the right direction to standardize the outside contour of the band itself. The recommendation of the Division should stand, permitting either the corrugated or the dovetail facing.

C. B. WILLIAMS: This report, I take it, relates to certain sizes and makes it optional whether the dovetail or the corrugated facing is used. Both of these sections are being used now. I think this discussion is all beside the point.

MR. SWAIN: The subject of contour was discussed at some length at the various meetings of the committee. It was the consensus of opinion that inasmuch as the contour shown in the report had been used successfully by one of the larger tire manufacturers and was one of the simplest rollings to secure from the mills, it was quite adequate for the purpose intended, to facilitate the application of the solid tire to the felloe band. I believe that the recommendations of the Committee should stand as they are in the report.

W. C. KEYS: The Committee considered a long chamber that ran back under the upturned flange of the band, but the point was brought out that this resulted in too little support in the mounting of the band. Therefore the recommendation given in the report of the Division was decided upon.

## (25) Base Bands for Industrial Truck Wheels

The sections of tires and base bands as recommended for solid tires for trucks also apply to industrial truck wheels, and the Division recommends that the recommended S. A. E. Standard 3½ and 5 in. pressed-on channel sections shown in the accompanying drawing be adopted for industrial truck wheels.

## (26) Solid Tire Sections

In first working on this subject the intention was to standardize the sections and contours for solid tires but

as this would tend to limit the design of solid tires, the Division recommends that the minimum total cross-sectional rubber area of solid tires on standard bands for commercial vehicle wheels shall be as shown in the accompanying table, which is in complete accord with the schedule worked out and adopted by the Solid Tire Division, War Service Committee of the Rubber Industry of the U. S. A. These areas include the hard and soft rubber used in solid tires and are recommended for acceptance as an S. A. E. Standard.

Solid Tire Widths, In.	Minimum Total Sectional Area of Rubber, Sq. In.
3½	6.75
4	7.75
5	10.75
6	13.75
7	16.75
8	19.75
10	25.75
12	31.75
14	37.75

#### (27) Wood Felloe Dimensions—Pneumatic Tire Rims

At the June, 1918, meeting of the Society wood felloe dimensions were adopted for only the 6, 7 and 8 in. rims. To complete this specification for 3½, 4 and 4½ in. rims, the dimensions recommended for S. A. E. Standard are as follows:

Nominal Tire and Rim Size	Width	Depth
30x3½	1½	1¼ (+½/-0)
32x3½	1½	1¼ (+½/-0)
33x4	1½	1¼ (+½/-0)
34x4½	*2 †2½	1¼ (+½/-0)

\*Width of felloes for rims with special sections.

†Width of felloes for demountable rims on cold-rolled bands.

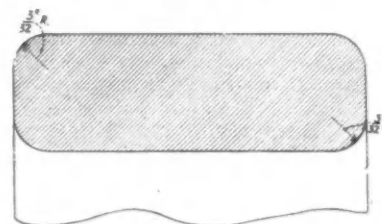
These felloe band dimensions conform with those adopted by the Automotive Wood Wheel Manufacturers' Association.

#### (28) Allowable Tolerances for Felloe Bands

The tolerances given on page 8a, S. A. E. Handbook, vol. I, are used for the inspection of not only steel bands on wood wheels but also for steel wheels. The Division recommends that the wording at the bottom of page 8a, be changed to read, "Band circumference after application to wood wheels and circumferences of steel wheels," to make the S. A. E. Standard applicable to both types of wheel.

#### (29) Edges of Felloe Bands

The present specification as revised at the June meeting in Dayton to 3/16 in. radius on the inside edges and 1/16 in., radius on the outside edges of bands, is a specification to which it is practically impossible to get the mills



EDGES OF FELLOE BANDS

to roll steel. The Division therefore recommends that the edges of felloe bands be changed to 3/32 in. radius for all edges. This proposal is approved by both wheel and tire manufacturers and is presented for acceptance as an S. A. E. Standard.

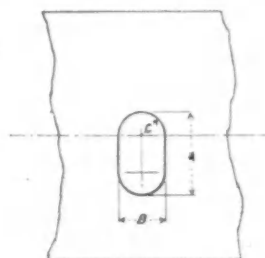
#### (30) Pneumatic Tires for Motorcycles

The present S. A. E. motorcycle tire sizes printed on page 8k, S. A. E. Handbook, vol. I, are 2¼, 2½, 2¾, and 3 in. sectional diameters. In order to bring the S. A. E. table up to date and have it complete, the Division recommends the following for adoption as S. A. E. Standard. As the tendency in motorcycle design is toward heavier types of machines, the recommended tire sizes are considered ample, and conform to the sizes recommended and adopted by the War Service Committee of the Rubber Industry of the U. S. A.

NOMINAL TIRE SIZE		OVERSIZE TIRE		TIRE SEAT, DIAMETER OF RIM		Type of Rim
In.	Mm.	In.	Mm.	In.	Mm.	
26x2¼	60/535	None	None	21	535	BB
28x3	75/560	29x3½	90/560	22	560	CC

#### (31) Valve Hole Size—Automobile Rims

A 5/8-in. diameter valve-hole has already been standardized for the 3½, 4 and 4½ in. rims. The Division



Rim Size (Inches)	Valve Hole (Inches)		
	A	B	C
6	1½	5/8	5/16
7	1½	5/8	5/16

VALVE HOLE SIZE FOR GIANT DEMOUNTABLE AND STRAIGHT SIDE TRUCK RIMS

now recommends valve-hole sizes for the 6 and 7 in. rims as shown on the accompanying drawing, to be included with the present Standards.



# Problems of the Naval Aircraft Factory During the War

By COMMANDER F. G. COBURN (Non-Member)\*

ANNUAL MEETING PAPER

Illustrated with PHOTOGRAPHS AND CHARTS

THE reason for the establishment of the Naval Aircraft Factory was the problem of aircraft supply which faced the Navy Department upon the entrance of the United States into the great world war. It is unnecessary to recite these conditions to the members of this Society. It suffices to say that the army's requirements for large numbers of planes promoted a decided lack of interest in the navy's requirements for comparatively small numbers of machines, and the Navy Department therefore concluded that it was necessary to build and put into production an aircraft factory to be owned by the Navy, in order, first, to assure a part, at least, of its aircraft supply; second, to obtain cost data for the Department's guidance in its dealings with private manufacturers; third, to have under its own control a factory capable of producing experimental work.

## APPOINTMENT OF AN INVESTIGATING BOARD

The Department directed that a survey of the situation be made early in June, 1917, with a report upon the size, cost, and location of a factory capable of producing 1000 navy school planes, known as Curtiss N-9, per annum, and further to report upon the minimum time in which such a plant could be built, equipped, manned and put into operation. The field for investigation was necessarily limited, as at that time only the Churchill Street plant of the Curtiss Aeroplane company could be considered a manufacturing plant for airplanes. There were a number of other firms producing planes in small quantities or getting ready to produce them in large quantities. But scanty information was therefore available and there was no time to make an exhaustive study that under ordinary peace-time conditions would be expected before embarking on an enterprise of this size. Consequently about the middle of July, 1917, it was reported to the Chief of the Bureau of Construction and Repair, Admiral D. W. Taylor, U. S. N., and to the Secretary of the Navy, that a plant of the required size could be built at the League Island Navy Yard at a cost of approximately \$1,000,000 in about 100 days.

On July 27, 1917, the Secretary of the Navy approved the project and directed the Chief of the Bureau of Construction and Repair to proceed with the construction.

## BUILDING CONTRACTS AWARDED

The contract for the buildings was awarded Aug. 6, 1917, ground actually being broken four days later. Beneficial occupancy of part of the building was obtained about Oct. 1, 1917, ahead of the time promised by the contractor. On Oct. 16, 1917, sixty-seven days after breaking ground, the first power-driven machine was put in operation and the entire building was pronounced complete Nov. 28, 1917.

The engineering data and plans for the planes to be built were received by the factory Oct. 26, 1917, and on March 27, 1918, 228 days after ground was broken and

151 days after receipt of the plans, the first machine was given its first flight, which was successful, and on April 2, 1918, this machine and the second one were shipped from the factory en route to England. These two boats were the first of the original manufacturing order, which was completed July 2, 1918, ahead of the time scheduled for its completion.

Some figures obtained as of Sept. 30, 1918, about a month and a half before the armistice was signed, will give an idea of the size of the factory at that time. It has been enlarged beyond the bounds of the original project, as will be described.

Total floor space, sq. ft. ....	750,000
Total ground covered including lumber yards, acres .....	41
Total number of employes .....	3,600
Of which were women .....	750
Value of plant, buildings, and equipment ....	\$4,476,000
Supplies in store .....	1,621,000
Work in process .....	1,662,000
Total inventory .....	\$7,759,000

## Value of output

- (a) 183 Twin-engined flying boats (at approximately \$20,000 each) ..... \$3,660,000
- (b) 4 Experimental machines, 50 sets twin-engined flying boat spares and a considerable volume of ordinary experimental and repair work ..... 200,000

Total value of output ..... \$3,860,000

Payroll for month of September, 1918 ..... \$405,000  
Total expended in wages up to Oct. 1, 1918... \$2,790,000

## THE ORIGINAL PLANT

The original plant consisted of a building 400 ft. square containing a balanced plane factory—that is, mill, metal shop, panel shop, covering, varnish, and dope rooms, hull shop and final assembly, together with the general offices, toilet and locker rooms, cafeterias, and storeroom. In addition there was a four-cell Tiemann dry kiln, a brick building 60 by 100 ft., heated, for the storage of kiln dried lumber, a lumber yard with modern pile bottoms for the accommodation of approximately 3,000,000 ft. of lumber, and a boiler house.

Fig. 6 gives the layout of the entire factory buildings, Nos. 1 and 2, constituting the original project, the block to the south of the main building, No. 5, being the lumber yard. The large building is made up of a section 300 by 400 ft. of the Austin Co. No. 3 building, and a special bay 100 by 400 ft. was added to supply hull building and final assembly space. This extra bay was 100 ft. wide with a clearance under the roof trusses of 51 ft., accommodating a 10-ton, three-motor, overhead traveling electric crane with a 40-ft. hook hoist. The provision of this high, wide, long bay seemed to many to be of doubtful value, but it was intended to meet the requirements of

\*Manager, Naval Aircraft Factory, Construction Corps, U. S. Navy.

the future, which it seemed certain would be for large planes, and as it happened the factory never went into production on small planes, but was started at once on large planes, making this building and its crane a paying investment from the start.

#### LAYOUT ASSURED FLEXIBILITY

The allocation of space to the various activities of the plant was a problem which did not at the time admit of definite solution because of lack of definite information as to the types of machine to be built and of information as to the amount of space actually required for known types of machines. The only partitions erected, therefore, were those necessary to meet the following requirements: First, to separate the high bay from the low part of the building, as a fire protection measure; second, to separate the offices, toilet and locker rooms and cafeteria from the factory for fire protection, cleanliness and quiet; third, to enclose the metal shop, and the varnish and dope room, as a matter of fire protection.

The machinery purchased was equipped with individual motors so that no provision for line shafting was necessary and the location of the machines could be changed at pleasure.

#### ATMOSPHERIC CONDITIONS STABILIZED

Having noted that a watering-pot was necessary to preserve the necessary humidity in airplane factories and realizing the desirability of standardized and constant atmospheric conditions as to temperature, humidity, and ventilation, the Carrier system of heating, humidifying and ventilating was installed. This is the system now being commonly used in cotton mills and was introduced into an airplane factory for the first time. It has automatic temperature and humidity control, the air condition being standardized at that which would provide a good working temperature (65 deg. fahr.) together with a 50 per cent humidity, which would insure that wood dried to 10 per cent moisture content would neither absorb nor give off moisture. It was then insured that small, and particularly thin, wood parts would maintain their size and shape after manufacture and thus facilitate assembling. The system proved most satisfactory.

Probably all plane manufacturers in the aircraft world went through the same distressing times experienced by the Naval Aircraft Factory of having to start work as winter approached in incomplete buildings without light and without heat, and without those conveniences and articles of equipment that are not appreciated by those who work in established factories.

#### PROBLEMS OF ENLARGEMENT

In December, 1917, it was decided by the Navy Department to make a very great increase in the aircraft building program to meet the requirements for planes for patrol and convoy work in the North Sea and particularly over the waters contiguous to the coasts of Ireland and France. Although at this time the Naval Aircraft Factory was not yet in production, its original plant was complete, the organization was formed and working, a fair start had been made on the assemblage of a working force, and it gave promise of coming satisfactorily into production. The new program necessitated the provision of additional manufacturing facilities because the army was not prepared to release any of the facilities assigned to it by the Aircraft Board.

The first problem was to decide whether or not to con-

struct a balanced factory to supply the needed capacity. After considerable discussion it was decided that the time required for the erection of the building, the assembling of sufficient personnel, etc., was so great as to preclude so doing. It seemed better to utilize idle plants in the industrial world for the production of parts and to erect as an enlargement of the Naval Aircraft Factory an assembling plant to be fed by these sources of parts and minor assemblies.

For this there was provided a building shown in Fig. 6, consisting of two parts: a low building 13 ft. under the roof trusses was provided for panel shop, varnish and dope room, pontoon manufacture, etc., and a bay 100 ft. wide, 51 ft. under the trusses and 680 ft. long for final assembly, flanked on each side by a bay of equal size, 50 ft. wide and 30 ft. under the trusses. The 100-ft. bay was equipped with two 10-ton, three-motor, overhead traveling electric cranes, and the side bays each with a 2½-ton small crane. The plan was to manufacture and assemble wings, pontoons, and similar parts in the low section, assembling them to jigs and packing them for shipment, the boat hulls to be put through final assembly, packed and shipped from the high bay, while the flanking bays were used for sub-assembling.

#### OUTSIDE PLANTS AIDED INCREASED PRODUCTION

As sources for hulls some six yacht building yards were obtained, and for the supply of wings, metal parts, tanks, engine foundation assemblies, tail surfaces, etc., the services of a number of plants were enlisted which might have otherwise stood idle due to the discontinuance of their peace time business.

The direction of the entire program was reposed in the central offices of the Naval Aircraft Factory, which necessitated enlarged office space. Therefore, a concrete three-story office building was erected to accommodate the offices and the old office space was put into production. A six-story concrete storehouse, approximately 200 ft. square, was provided to meet the enlarged storage space requirements and the storage room in the original factory was thrown into production space. The dry kiln capacity was doubled, as was also the heated storage building and the lumber yards. The success of the Carrier heating and ventilating system in the original plant dictated its installation in the new assembling plant and in the heated lumber storage building.

At this time there was also projected a hangar which was authorized in the spring of 1918 and is now under construction, because of the increase in experimental work, in the development of new models and of new features in old models, necessitating a considerable amount of alteration on completed planes and test and demonstration flying. The Delaware River affords ample space and climatic conditions are favorable, except for two months in the winter.

This hangar has a door 200 ft. wide and 50 ft. high, and the building itself is 150 ft. deep. In front of this hangar is an apron 100 by 200 ft. made of concrete with a concrete ramp flanked by concrete piers. The concrete is to be colored green to relieve the glare. Provisions are made for the simplification of handling planes on the apron and ramp.

The Philadelphia Navy Yard is on League Island, which comprises approximately 1000 acres, of which over 41 acres are covered by the enlarged plant. A considerable increase in paving, railroad tracks, roadways, etc., was required and was provided for in the allotment, which, including the hangar, amounted to \$3,678,000, which was

## PROBLEMS OF THE NAVAL AIRCRAFT FACTORY DURING THE WAR

161



FIG. 1—CURTISS R6, A PONTOON SEAPLANE; SIMPLY A LAND MACHINE WITH PONTOONS INSTEAD OF WHEELS

approved for the project by the Secretary of the Navy Jan. 27, 1918.

In the design of the buildings provision was made for sprinklers and the buildings were also supplied liberally with fire buckets, sand boxes, and fire extinguishers.

Responsibility for the securing, development and retention of a satisfactory personnel, outside of the executive staff, was placed in an Employment Department, under the direction of an Employment Superintendent. The Employment Superintendent is one of the five main department heads reporting to the manager. The specific functions assigned to the Employment Department originally included employment and training. Later, as the work developed, responsibility for a certain amount of factory follow-up and for all service work of the factory was added.

## TRAINING WOMEN

When the factory was starting it was necessary to employ men almost entirely for mechanical work. As soon as a sufficient number of men had been trained to carry the work along, it was considered not only desirable and necessary to use women wherever possible, but also a war duty. The most important training work taken up by the Employment Department had to do with the introduction of women into the factory.

A training school was established for women. Upon employment women were placed in this school and there under close supervision of mechanic instructors, performed the same kind of work which they would later be called on to perform in the factory. The work which they do is production work, but it is graded so that a beginning worker has similar work and is more closely supervised. With these exceptions and the exception of a somewhat shorter working day, the working conditions of this school are made to resemble as nearly as possible the working conditions of the rest of the factory. A sufficient number of girls passed through the school to increase the number of women employes from 218 in June to 895 in November. This was an increase from 9.4 to 24.5 per cent of the entire force.

Most of the women employed on mechanical work were

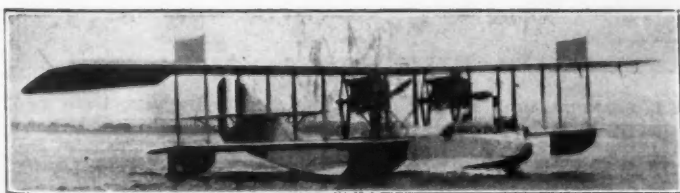


FIG. 2—THE FIRST PRODUCT OF THE NAVAL AIRCRAFT FACTORY WAS A CURTISS H-16 FLYING BOAT  
It Is a Tractor Biplane with Twin Liberty Engines

used in the assembly of airplane wings, but they were also extensively used in the metal and machine shop, in the wing covering department, in the sawmill, in the hull

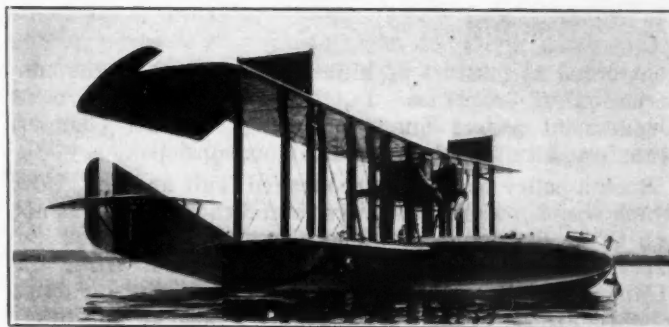
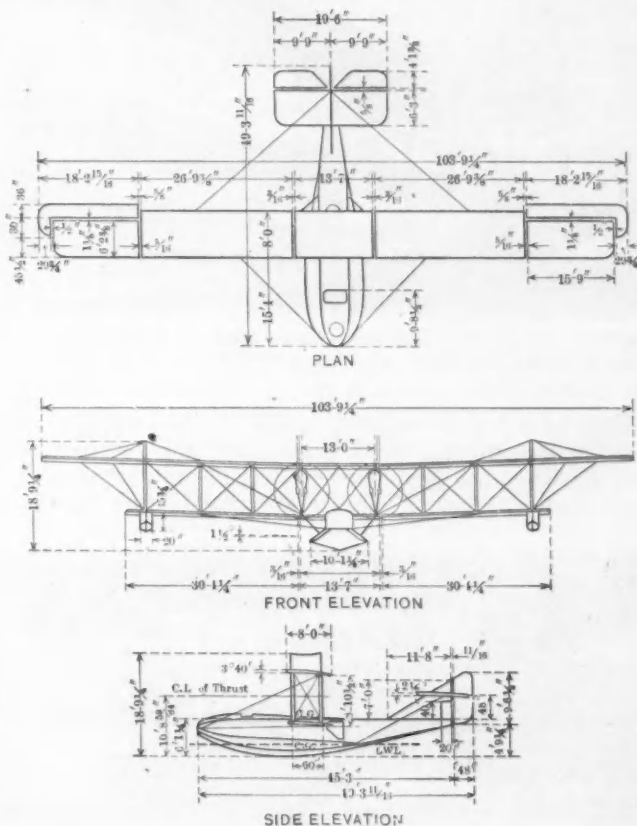


FIG. 3—THE F-5-L BOAT SEAPLANE, A REFINED AND LARGER EDITION OF THE CURTISS BOAT  
It Has a Wing Spread of 104 Ft., a Total Flying Load of Nearly 7 Tons and a 10-Hr. Cruising Radius

shop, in painting, in subassembling, in inspection and in the storeroom.

A similar training course was conducted in the factory for the enlisted men who were to be sent abroad for assembly and repair of seaplanes.

## DEALINGS WITH EMPLOYEES

In dealing with employees the theory that every employee had the right of appeal to the Manager was followed. In most plants a man's future and happiness are dependent upon his immediate superior's judgment. Ordinarily that judgment is sufficient and is just, but it frequently is not, and it was considered good business to have a department where someone who was not responsible for production and under the pressure that it implies might fairly consider both sides of each dispute and

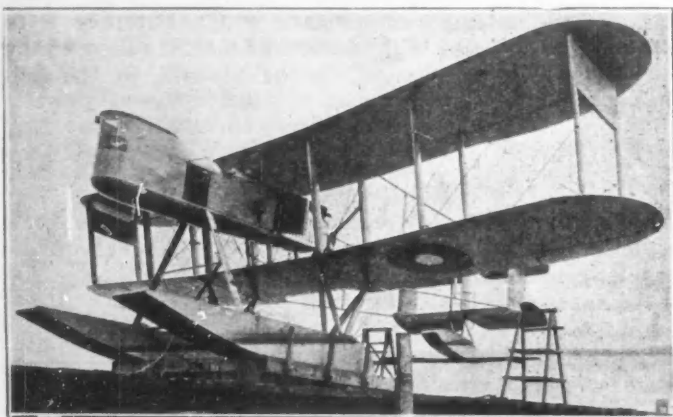


FIG. 4—A PONTOON PUSHER SEAPLANE OF THE FAST SPEED SCOUT TYPE WHICH WAS DESIGNED, MANUFACTURED AND PERFECTED DURING THE WAR

render an ex-parte decision. Since the Manager was too busy to assume this work personally, this responsibility was placed in the Employment Department, where grievances and charges of unfair treatment were regularly

and experimental models. During the war its function was to be practically one of production. Located as it was in the Navy Yard and in charge of an officer known as the Manager, it was necessary for the Manager to be under the Commandant of the Navy Yard insofar as military matters and matters of general external policy were concerned.

The Bureaus of the Navy Department provided an independent inspection service at the Naval Aircraft Factory under the general direction of the Bureaus, just as the same service was furnished to privately owned factories. Communication with other plane factories was direct on matters not involving the inspectors' interests directly and correspondence was through the inspectors under the same conditions as those imposed upon private manufacturers.

#### ENGINEERING PROBLEMS INVOLVED

One of the principal problems of the Engineering Department was to apply the practice of part design for matching production to the manufacturing problems of the factory, and in the second model put into production, the F-5-L, a considerable difference was made to facili-

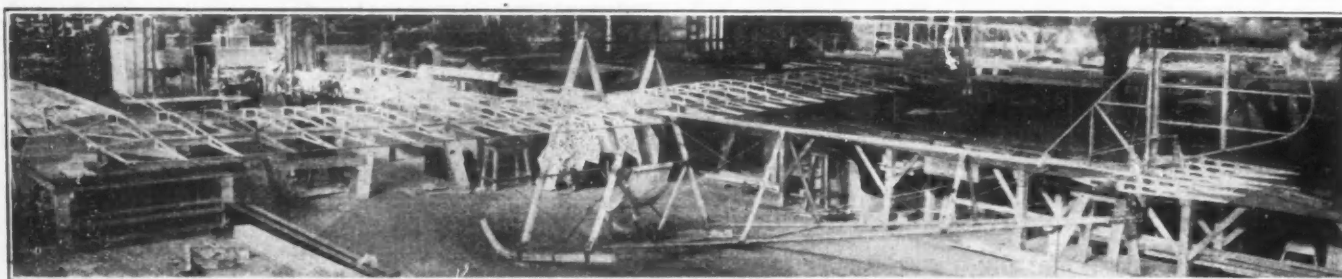


FIG. 5—SKELETON OF A SMALL PLANE BEING DEVELOPED FOR FLYING FROM A BATTLESHIP. It is a 26-Ft. Span Monoplane and Complete with Pilot Ready for Flight Weighs Less Than 600 Lb.

considered as matters of highest importance to the construction of seaplanes. Furthermore the Employment Department passed finally on nearly all rate changes, transfers, all discharges and draft exemptions.

Such a policy may have encouraged fault finding. That which was at bottom constructive and that which was not had to be distinguished. There was dependence on the department for straightening out difficulties. After the armistice was signed, when the plant was cutting down its force, those who so desired were helped to find other work.

#### UTILIZATION OF THE PLANT

At the time the plant was first projected, it was not known definitely what planes would be put into production therein, but it was designed practically with the idea of manufacturing training planes. Early in October the supply of training planes being assured and the supply of service flying boats being in doubt, it was decided to put into production an order of fifty twin-engined flying boats of the type known in England as F-2-A and in the United States as the Curtiss model H-16.

The engineering data were obtained from the Curtiss Aeroplane & Motor Corporation and to discuss the engineering problems involved, it is perhaps necessary to show the relation between the Naval Aircraft Factory, the Navy Department and other airplane factories. The Naval Aircraft Factory was designed to supplement, not to compete with, privately owned factories, its after-the-war future being intended for the development of new

tate manufacture in many features. For example, metal fittings were designed to avoid as far as possible the use of drop forgings, as material for the former was easily obtained, easily worked and welded and would lose little

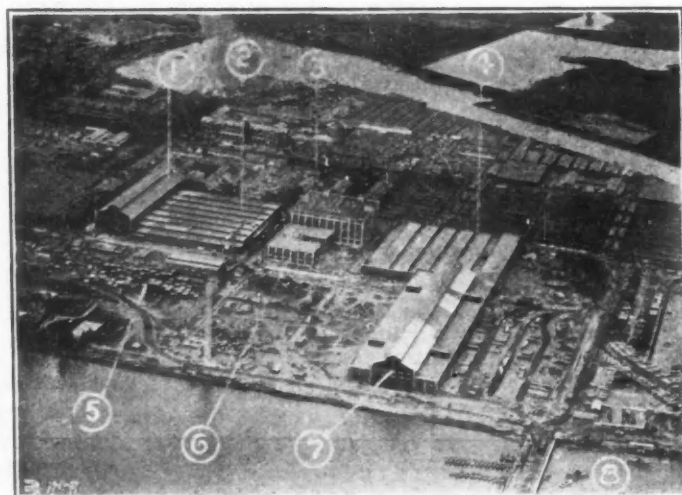


FIG. 6—AIRPLANE VIEW OF THE FACTORY TODAY, SHOWING BOTH THE ORIGINAL AND ENLARGED PLANT

- (1) High shop No. 1; original plant.
- (2) Mill, metal shop, offices, and storeroom of original plant.
- (3) The storehouse.
- (4) Panel, pontoon, paint and dope rooms of the enlarged plant.
- (5) Lumber yard, dry kiln and boiler house.
- (6) Office building.
- (7) Assembly shop, of the enlarged plant.
- (8) Hangar.

strength if abused. Fig. 10 is a typical example. Often the most complicated fittings were so designed that they could be assembled, drilled, brazed, etc., by women. In the hull of the first model there were about fifteen different kinds of strap fittings for securing stanchions to each other and to the longerons. By reducing the number of different kinds of fitting, the number of dies, tools and jigs for their production was reduced, it was easier to supply the shop and there was less opportunity for confusion; hence "average fittings" were designed so that some one kind of fitting could be applied to two or more different places. The result of this practice was that no fitting seemed exactly to fit, but outside of the loss in appearance the net result was a gain. Fig. 11 shows some typical average fittings.

In many cases, particularly at first, substitutions were necessary on account of lack of specified materials or parts. The Engineering Department was called upon to suggest and to pass on substitutes. Many times reference to the stress diagram enabled a simple substitution which saved a great deal of time and aided production. All such substitutions were, of course, taken up with the proper Bureau of the Navy Department and authorized.

#### THE ENGINEERING DEPARTMENT AND PRODUCTION

In getting the factory into production, this service of the Engineering Department was of inestimable value, also in the investigations of spiral grain and the use of laminated members for struts and wing beams. Early practice dictated that struts and wing beams should be made in two pieces and lightened. The difficulties in the way of getting materials of the proper quality in the necessary large sizes finally brought about the adoption of laminated pieces. Struts, for instance, were made with three laminations, and each lamination might be in two pieces, making six-piece struts. Wing beams were at first spliced, then laminated, and then the laminations were spliced, and finally instead of two laminations three were used. Examples of each are shown in Figs. 12 and 13.

In working out this practice it was found that apparently good struts would warp or in testing would fail under small loads. Investigation disclosed the fact that the laminations must be of equal density to avoid these faults. For instance, in the two-piece strut if one lamination is of greater density than the other, the lamination of light density would yield under load more readily than the heavy lamination, thus throwing all the load on the heavy one and bringing about early failure. Further study made it necessary to match not only in density but in grain, as is illustrated in Fig. 14.

The Wood Technology Section was faced with the problem of discovering why during the winter from nine to ten o'clock every morning the steam-bent spruce and ash stringers would start breaking; one morning five bent members broke within half an hour. Investigation developed the reasons. It had been customary to allow the temperature in the plant to drop during the night to 50 deg. fahr. and starting at seven o'clock in the morning the temperature was brought up and by nine o'clock would be normal (65 deg. fahr.) The wood could not conform so rapidly to the changing atmospheric conditions, and the attempt to conform introduced internal stresses which broke the pieces. Thereafter the night temperature was held at the level of the day temperature and the trouble disappeared.

Considerable difficulty was experienced in getting satisfactory wood inspectors, due to the refined requirements.

Defects that were not important to the commercial inspector of lumber or inspector of wood parts were found to be of prime importance in the aircraft factory. The question of strength was, of course, paramount, and thus it was necessary to discover hidden defects, and hidden defects are quite common in spruce.

#### WOOD DEFECTS A PROBLEM

Three of these defects difficult to observe are pitch pockets, spiral grain, and compression failure, none of which was very clearly recognized before the war. A typical example of spiral grain is shown in Fig. 15. Spiral grain is exceedingly difficult to detect, particularly in fresh cut material and is exceedingly treacherous, especially under shock or impact. This defect was given magnified importance at one time, but even after the excitement had subsided its danger was appreciated and has been minimized largely by the practice of laminating. A piece containing spiral grain will split straight along the growth grain, but will cleave at a distinct angle across the growth grain. It is discovered by looking for indistinct and sometimes nearly invisible veins of sap. The Engineering Department made a long series of tests in the study of spiral grain and with the strength data obtained and after a study of the stress diagram, spiral grain tolerances were modified and reduced, which greatly facilitated the production program.

#### BOLT PRACTICE

In the design originally put into production in this factory, the variation in diameter of bolt was by  $1/32$  in. and in length of bolt by  $1/16$  in. As these bolts were all of special dimensions and of special stock, heat treated and electroplated for protection against corrosion, and as the number of sizes was great, production difficulties and complications arose due to long parts lists, numbers of drawings, specifications, contracts, stockbins, stockcards, etc. Therefore, five diameters were adopted as standards by the Department, namely  $3/16$ ,  $1/4$ ,  $5/16$ ,  $3/8$  and  $1/2$  in. and the variation in length was made by  $1/8$  instead of  $1/16$  in. By this means the number of sizes was reduced enormously.

In the early practice castle nuts and cotter-pins were used on all bolts. These bolts were, of course, hardened by heat-treatment and it is exceedingly difficult to drill them on assembly, requiring much time, causing the breaking of many drills, and frequently on wing panels, resulting in damage to the fabric which required patching. This practice was immensely simplified by the use of washers under all nuts bearing on metal surfaces; and nuts bearing on wood surfaces were headed over unless it was necessary to have them readily removable. This reduced the assembling time of many assemblies and further simplifies the production problems.

#### HOW MATERIAL WAS OBTAINED

At the time the factory was projected the markets had been pretty well cleared of available stocks and the operation of the priority system had not been satisfactorily worked out by the Government, so that the material problem was exceedingly difficult. The factory being a beginner had absolutely no stocks. It was necessary to buy all materials through the purchasing routine of the Navy Department, buying on specifications and only after the widest possible competition. Materials were just beginning to come in when the freeze-up and traffic paralysis occurred, and much valuable time was lost.

Another problem faced the Supply Department, due to

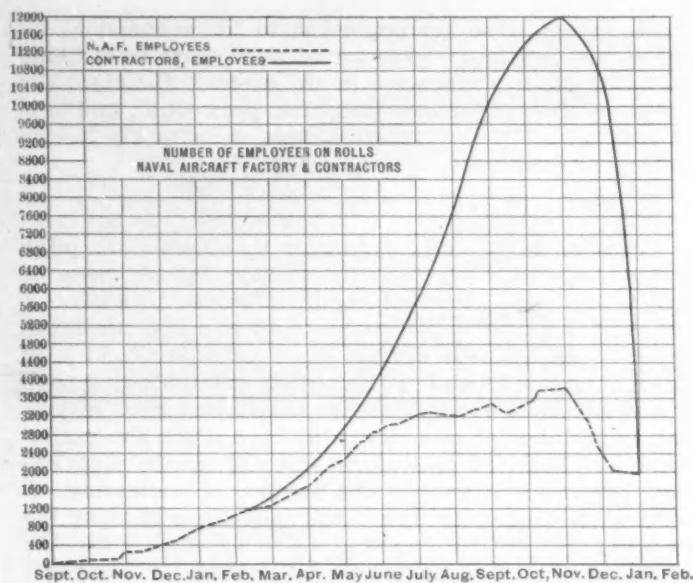


FIG. 9—CHART SHOWING A CONSTANT INCREASE IN THE NUMBER OF EMPLOYEES UP TO THE TIME THE ARMISTICE WAS SIGNED, THE SOLID LINE INDICATING THOSE EMPLOYED AT THE FACTORY AND THE DOTTED LINE THOSE EMPLOYED IN CONTRACTORS' PLANT

the policy that the Naval Aircraft Factory should add to the aircraft industry. It followed that as the principal dealers in aircraft materials had all, or nearly all, of the work they could handle, it was necessary to develop new sources of supply. A force of traveling representatives was kept on the road to interest new plants, and to investigate bidders' capabilities to deliver goods; and they were later used to expedite production in these sources. Particular attention was paid to the task of teaching these vendors how to manufacture materials and parts to meet specifications and requirements of the aircraft industry.

This section was supplemented by a traffic and follow-up section, which attended to the routing of traffic and following it on the road, and the factory, like all other aircraft factories, operated a "suit-case express" to meet its own urgent requirements and those of its sub-contractors.

The Naval Aircraft Factory is a larger institution than the entire Navy Yard was before the war. It used in manufacturing over three times the quantity of lumber that the League Island Navy Yard uses at the present time. It handled more shipments per day than even the

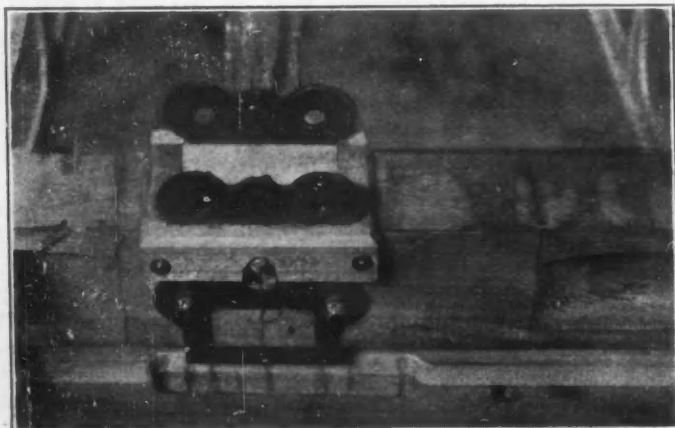


FIG. 10—A TYPICAL F-5-L FITTING USED ON THE WING BEAMS  
Note That It Is Strap Iron Cut from a Flat Pattern

New York Navy Yard before the war. Up to the signature of the armistice the lumber yard received 16,000,000 board ft. of lumber and stored it properly; 7,759,000 board ft. were used in manufacturing or shipped out to sub-contractors for the manufacture of hulls or parts; and there remained about 6,000,000 ft. in the yard at the cessation of hostilities.

#### RAIL SHIPMENT UNDESIRABLE

A perplexing problem was the loading of completed flying boats. On account of the large dimensions of the hull case, rail shipment was undesirable. Boats shipped by other manufacturers in this way having been damaged, shipment by canal barge was developed and proved successful, except, of course, in case of those planes shipped abroad from the factory. Every plane loaded at this factory arrived at its destination without damage due to shifting of cargo or other incident attributable to the method of securing it.

#### SOURCE OF SPRUCE

The spruce supply problem was solved by the Navy Department in contracting for New England spruce. This comes in smaller sizes than the Western spruce; but by



FIG. 11—MANY OF THE HULL FITTINGS WERE SIMILAR BUT NECESSITATED DIFFERENT DIES, PATTERNS, ETC.  
Hence "Average Fittings," Several of Which Are Shown, Were Designed

laminating beams and struts, and by splicing beam laminations, purchase of army spruce at from \$300 to \$750 per thousand was discontinued and navy New England spruce was taken at from \$100 to \$125 per thousand; also 2,500,000 ft. shipped overseas for aviation purposes.

#### CHANGES IN CONSTRUCTION AND DESIGN

Many changes in construction were necessary for a number of reasons. In spite of the utmost effort, drawings were frequently incorrect, because of insufficient

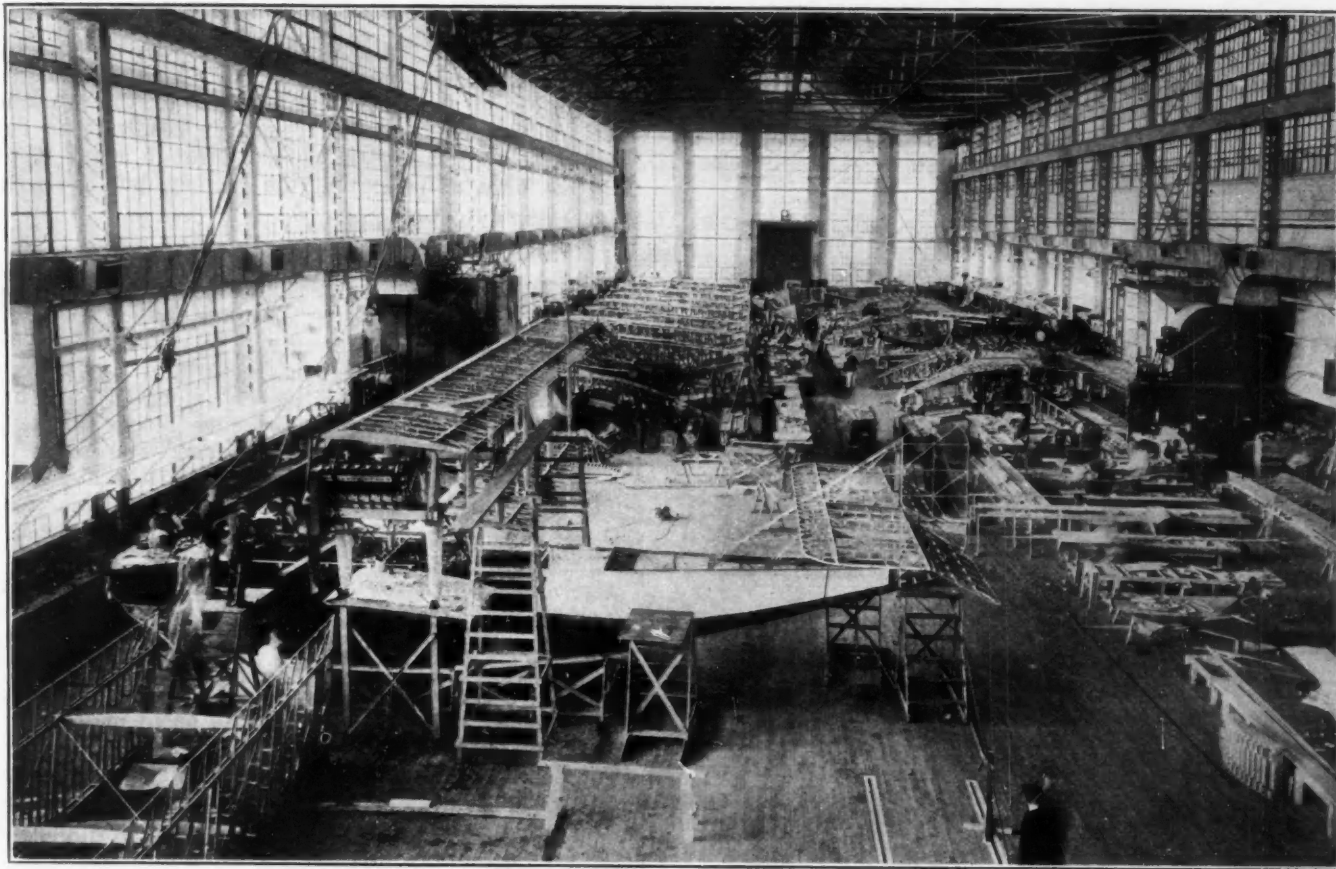


FIG. 7—PLANT NO. 1—ASSEMBLY AND HULL SHOP SHOWING THE CARRIER HEATING, HUMIDIFYING AND VENTILATION SYSTEM INSTALLED



FIG. 8—THE ASSEMBLY PLANT OF THE ENLARGED FACTORY WAS ORIGINAL ON A FORD ASSEMBLY SYSTEM BASIS

data on the strength or nature of materials, because of hurried preparation to meet requirements of the shop, or incomplete checking because of limited time. There were also changes in design to permit substitution for materials not obtainable, or eliminate weakness developed

The variety of materials required was greater than would at first be supposed; many of which were, both in character and treatment, unfamiliar to the workmen, necessitating experiments, frequently resulting in ruining parts. All materials passed through rigid inspection, not only on receipt at the factory, but after each stage in manufacture.

#### SPECIAL TOOLS AND FIXTURES

Methods, tools and appliances were in many cases new or untried, or adaptations from other trades, as, for example, an emergency blanking die, good for from 100 to 500 pieces, which could be manufactured in our toolroom in from 12 to 24 hr. The die was mounted on a base and separated therefrom by spacing blocks somewhat thicker than the material to be punched. The punch was a loose piece of machine steel guided to the die by the guide block, held in position above the die. This device was used on ordinary stamping presses for material to and including  $\frac{1}{8}$  in. thick.

Jigs and fixtures for bending, welding, cutting, drilling and testing, frames for setting up an assembly, were developed and built up by crews in each shop designated for the purpose.

A feature new to most of our workmen was the small tolerance permitted in wood, as well as in metal, to secure minimum weight and avoid hand-work in assembly.

The floor space allotted to the various shops was based on the speed requirements indicated by the program chart, and so arranged that the flow of material was as much as possible in a forward direction, with a minimum of backtracking, and subassembly storerooms were located at convenient points in the line of flow of material, between the shop where the part was manufactured and the shop where it was used. In this manner large storage areas were avoided and the subassembly storerooms were continually under the eye of the shop foreman, while records of their contents could be reported daily to the manufacturing office, where the records were kept and orders so issued so as to keep the various crews busy, to avoid accumulation of parts, thus saving floor space and delivering finished parts and sub and major assemblies when, where and as required.

#### HOW PRODUCTION WAS MAINTAINED

The first order was for fifty seaplanes to be delivered by Aug. 1, 1918. Early in March a program was mapped out after consultation with the foremen of the shops, showing when we could reasonably expect to complete the first plane, then in process of construction. With that as a beginning date, a curve was drawn to July 1, the date of completion, showing the number of planes to be completed week by week, increasing as the men became expert in their work, more men could be secured and trained more rapid and uniform supply of parts secured, and the organization improved. From this program for finished planes there was prepared a schedule showing dates on which were to be completed each hull, each set of panels, etc. From this in turn were scheduled the dates on which the necessary number of metal, wood and other parts would be required, then the dates on which materials for such parts should be delivered and tools for their manufacture secured. These fundamental schedules were placed in the hands of the Supply Department, Employment Department and foremen, and systematically followed up, the progress made in securing men and materials being followed by progress curves, which were compared daily with the schedules showing like requirements. This method not only gave warning ahead of time of



Fig. 12—Built-Up Laminated Section Struts. These Were Designed to Save Material and, Having a Uniform Section, Were Easier to Construct. The Upper Two Views Are a Section and Plan View of the Old Type Two-Piece Tapered Section Strut That Required a Large Amount of Material and Much Hard Work. The Next One Is a Section of the New Six-Piece Type in Which Small-Section Material May Be Used, While the Bottom View Shows the Lightened Center Section

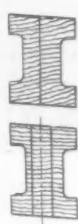


Fig. 13—Method of Building Up Laminated Beams Which Were Found to Be Better Than Solid Beams as the Possibility of Defects in Any One Part Decreased. The Upper Row Are of the Two-Piece Construction and the Bottom One Shows the Three-Piece Construction



Fig. 14—Laminated Struts Would Warp if the Grain in the Laminations Were Not Balanced. This Shows the Correct Method of Balancing the Grain. The Ideal Types Are Shown at the Top with the Acceptable Ones in the Middle and the Non-Acceptable Types Underneath

TYPICAL EXAMPLES OF THE USE OF LAMINATED SECTIONS FOR AIRCRAFT BEAMS AND STRUTS TO SAVE MATERIAL AND LABOR

by test, or provide improvements found necessary by overseas use, reduction in weight, or to further standardize or reduce the number of parts. All these changes had to be met with the least interruption to the shop schedule which had been prepared for the parts in question.

what would be required by each foreman for the accomplishment of his program, but also told him what would be required from his shop on any given date.

Drawings and instructions were scheduled in the same manner, which made it possible to concentrate first on drawings for parts which required longest to manufacture or which were needed earliest in the construction of the plane.

In the usual manner the manufacture of wood and metal parts, assembling of panels and hulls, painting and final assembling were assigned to separate shops; the work of each separate shop being further subdivided by crews doing similar work, every effort being made to select for these crews men or women who were, by previous experience or shop training, familiar with the particular type of work.

As an illustration of the advantage of subdividing the work so that each man was given a job which he could repeat day in and day out, there is cited the method of building hulls. The earlier hulls were each built by separate crews, each building a hull in its entirety, and as a natural result each man in the crew performed such a variety of work that no one did enough of any one thing to learn how to do it well and rapidly. The shop was full of hulls in various stages of completion, it was with great difficulty that the materials required by each crew were kept on hand, and more or less confusion was the result. There were nine of these crews, varying in size from 15 to 25 men, and the first step in separating the job into its component parts was to select the operation requiring the greatest number of man-hours. This was found to be the planking of the bottom of the hull. At first this operation required a crew of 20 men, working  $4\frac{1}{2}$  days, or 900 man-hr. By increasing this crew to 40 men, the time was reduced to one day or 400 man-hr., the men working without interfering with each other or any other crew, as the hull was theirs for that day.

#### HOW TIME WAS SAVED

The construction of the hull was divided into such operations as framing, brace wiring, planking, etc., each of which covered a similar kind of work. These operations were then grouped so that as many crews as possible could work on the hulls at the same time without interfering with each other, after which the various crews were built up so that each group of operations was completed in one day. By this method the time required to complete a hull was reduced from 41 to 16 days, which not only saved time and men, but floor space as, by providing sixteen berths, we secured a delivery of one hull per day; by apportioning the construction of the hull to 16 crews, each doing a day's work on each hull, it was practicable, by having 16 planes under construction, to have all planes simultaneously undergoing separate operations, and have each crew move from one plane to the next at the end of each day, thereby giving place to the crew performing the next operation. The speed of delivery was later raised to more than one plane a day by increasing the number under construction at one time.

The same method was followed out in the final assembly of planes. Whereas the first plane required for its final assembly 50 days, with a crew of 35 men, the second 27 days, the third 17 days, this time was finally reduced to 7 days. In the subdivision of work in final assembly, every effort was made to remove from the plane such work as could be done elsewhere; as, for example, the wiring of the hull for heat, light and ignition. At first this

required 114 man-hr. per plane. By assembling parts on benches, this was reduced to 73 man-hr. per plane. The time on the plane itself was at first 30 hr. and was later, by the use of jigs, reduced to 10 hr. The advantage was not only in the reduction of labor cost but also in the completion of the work in a short time. The hull is delivered to the final assembly floor with the wiring-board in place. This board is removed, placed on a jig, and in  $1\frac{1}{2}$  hr. is ready to replace on the plane. In 30 min. after

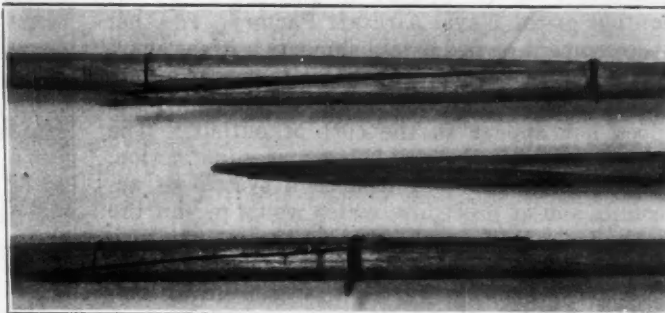


FIG. 15—A TYPICAL FAILURE DUE TO SPIRAL GRAIN IN A SPRUCE STRUT

the wiring-board is completed on the jig, it is replaced in the plane and all dependent operations may proceed; the wires having been previously cut to gage, terminals fitted and soldered, wires assembled by charts, and errors practically eliminated. It may be mentioned that the work on this jig covered three systems of wiring, namely, heat, light and ignition; and that women learn to do this portion of the work in a day.

Another example of the subdivision of labor is in the

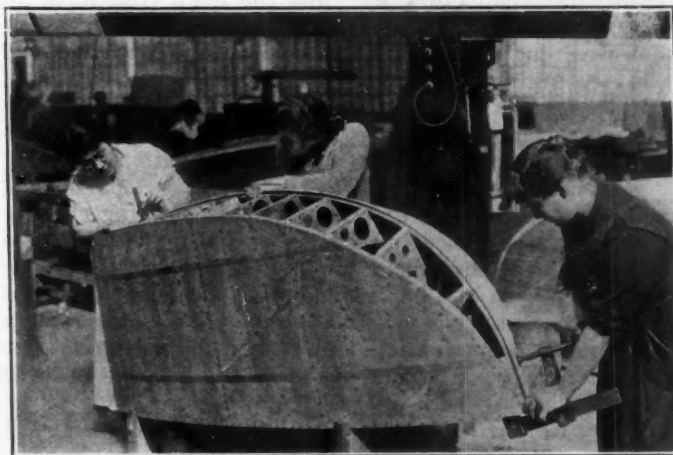


FIG. 16—AT FIRST 279 MAN-HR. WERE REQUIRED IN PONTOON CONSTRUCTION  
By Dividing the Work Into Operations, of Which This Is One, the Time Was Reduced to 40 Man-Hr.

construction of pontoons, which, under the first method of having one crew build the pontoons complete, required 279 hr. per pontoon. By dividing the construction into various operations, each performed by a separate crew, the time was finally reduced to 40 hr. per pontoon.

As to progress in cost reduction, it may be stated that the factory cost, including overhead, of the last twenty boats, out of the first order for 50, was less than half that of the first ten, and was considerably less than the price at which the Navy was buying these boats from other plane factories.

### COST RECORDS AS ESSENTIAL AS PLANES

One of the chief reasons for the establishment of the Naval Aircraft Factory was to obtain data on the cost of aircraft and aircraft parts for the information and guidance of the Navy Department and its Bureaus in dealing with private manufacturers. It was obviously necessary, therefore, that all those elements of cost with which the private manufacturer is burdened should appear in the course of the output of the Naval Aircraft Factory. In other Government-owned establishments a great share of the burden is charged direct to operating appropriations, under the Navy Department, and does not appear in the cost of output. The Naval Aircraft Factory being a new institution, it was arranged to introduce a system of accounts and of procedure which would permit the inclusion of all overhead, and the scheme was successful. The overhead contains interest on plant, depreciation (after the first year) and allowances for all the other standard items except profit and taxation. Even the salaries of Naval officers are included in the costs.

In this Department, as in the Supply Department, it was necessary to conform to statute, Navy regulations and the requirements of the Treasury Department, and of course in such a way as not to interfere with the establishment of a thoroughly practical commercial cost-keeping system. It will readily be seen that its immediate and difficult problem was to observe these multitudinous requirements with a perfectly green crew. Timekeepers, for instance, were recruited from the industrial force of milk wagon drivers, trolley car conductors, etc., and the word chaotic is the only one to use in describing the early condition which, however, due to the energetic and clear headed work of the Accounting Officer, was soon put on an orderly basis, with the result that the Naval Aircraft Factory payrolls and other financial returns were made promptly and accurately and in conformity with the regulations.

Expense was distributed to the different departments, according to its nature; that is to say, building charges on the basis of space; machinery and equipment charged on the basis of equipment supplied; supervision and similar charges on the basis of services rendered. It was and is the intention eventually to apply expense by a machine rate method, but it being necessary to get started quickly, a man-hour basis of distribution was adopted to begin with and is still in use.

Every worker has a time-card for every job every day and every item issued from stores is covered by its own separate stores requisition. Costs are kept by production order and are separated out and reported by appropriations and according to all the detailed requirements referred to in general above.

Space forbids discussion of the problems involved by the exclusive cognizance of the Bureaus of the Navy Department over its own appropriations. If space allowed, a statement of the various restrictions would be as interesting as their application was difficult.

### OUTSIDE CONTRACTS HANDLED SEPARATELY

The term contract manufacturing is intended to cover the production of hulls, assemblies and parts by private manufacturers for assembling at the Naval Aircraft Factory, as called for by the enlarged program referred to above. This required a separate department. It will



FIG. 17—A LARGE  
EXPERIMENTAL  
FUSelage

probably be agreed that it is much more difficult to hire other plants to do one's work than to do all the work oneself, because of the difficulties in placing orders, contractual relations, getting the contractor to manufacture the goods as wanted and deliver them when wanted, the difficulties introduced by transportation, to say nothing of the difficulty of maintaining quality and holding down prices.

In this particular case the problem was much more difficult because none of the contractors understood the work and they and their workers had to be taught. Although every effort was made to choose sources already completely equipped, this was not practicable, and it was necessary to add to contractors' equipment in many cases and to a considerable extent. The war conditions made it hard for private manufacturers to get material and labor and to hold their labor. Transportation problems were difficult beyond all expectation and altogether the manufacture of parts in subcontractors' plants is an undesirable policy. In defense of it, there can be said this, that the Naval Aircraft Factory got its parts almost as fast as they were wanted and that by dint of exceedingly careful and thorough instruction, the required standard of quality was maintained. Also the Navy finds

itself, now that the war is over, with a much smaller plant expenditure on its books than it would otherwise have had.

The policy in placing contracts was to select plants as nearly as possible properly equipped and of manufacturing experience which made their organization and personnel readily adaptable to the production of aircraft; also to establish for each part or assembly two or more sources in different localities, so as to protect the manufacturing program against interruption in supply, due to fire, labor, transportation or other difficulties.

In each plant was established a branch office of the Naval Aircraft Factory in charge of a Branch Manager, with production, inspecting and teaching assistants. Service was extended to the subcontractors in getting material and labor, because the Naval Aircraft Factory organization knew better how to deal with the bureaus of the Navy Department and with the other departments, commissions and boards of the Government.

Most of the contracts were made on a cost plus profit basis and, therefore, in each plant the Bureau of Sup-



FIG. 18—THE FACTORY HAD A PLANE READY EVERY TIME THE NAVY  
WANTED ONE  
A Few Shown Awaiting Shipment

## AMERICAN AVIATION FORCES IN FRANCE

169

plies and Accounts established a Cost Inspector. No extraordinary difficulties were experienced by the Naval Aircraft Factory in the operation of these contracts.

The reason for having a separate organization of the Contract Manufacturing Department was found in the fact that the manufacturing department of the factory proper was struggling with its own program and making good headway and it seemed better to establish a new organization than to interfere with and possibly destroy a satisfactory organization before it had acquired the stability of motion derived from experience and habit.

Later, as the original organization became stabilized, the disintegration of the Contract Manufacturing Department was begun. Inspection was first taken over by the Engineering Department. Later the Material Section of the Manufacturing Office took over general charge of the entire manufacturing program. Again, the largest source of metal parts and assemblies, which had at first been under the cognizance of the Contract Manufacturing Department, was shifted over to the Manufacturing Department and one of its superintendents placed in charge of the work there. The cessation of hostilities found the Contract Manufacturing Department reduced to about half its original size and scope.

## BACK TO A PEACE BASIS

The present date finds the Naval Aircraft Factory reduced in volume of work and changed in its policies and class of work. At the time the armistice was signed there were employed in the Naval Aircraft Factory proper some 3740 persons and in the plants of subcontractors nearly 8000 more. Work has been discontinued in the subcontractors' plants and the force at the factory reduced to 2000. The large new assembly plant has been converted into an aircraft storehouse. The storehouse building is being filled with raw materials and partially or wholly manufactured parts and assemblies. The large-scale production of boats has been stopped. Those boats which were so far along as to make it good business for the Navy to protect its investment by completing them

are being finished and being good standard craft will be suitable to the peace-time uses of the Navy.

The factory is giving its attention to the manufacture of training planes and to the designing and construction of experimental models; developing the art of flying. Figs. 16 and 17 show some of the work that has been and is being done.

In the stopping of work in subcontractors' plants the policy was adopted of effecting an adjustment which would be mutually satisfactory. No arbitrary cancellations were issued. So far as possible opportunity was given the contractor to taper off his work and to return to peace-time activities without any greater shock or disturbance to his organization than could be accommodated by its inherent elasticity.

It has been a pleasure to recite the story of the problems of the Naval Aircraft Factory and it is hoped that the recital has been interesting. The Naval Aircraft Factory is indebted largely to the automobile industry, to automobile engineers and to this Society for the help it has received in numberless ways, appreciation and thanks for which it is a privilege to extend.

## THE DISCUSSION

M. W. HANKS.—Commander Coburn's description of the activities of the Naval Aircraft Factory is almost as good as a trip through the plant, but not quite. If you could see the way he gets after a hold-up in production you would more fully appreciate his organization. One thing, possibly more than any other, that makes it possible to locate trouble is the exactness of the specifications for material. Being assured that the material is right when it enters the factory, through proper inspection, also assures you that the finished product will be right. Commander Coburn sees to it that the material is right and that it is treated right. One would hardly endeavor to start a large production without specifications. It is equally important that the material furnished for that production also be purchased according to specification so as to insure a uniform product at lowest possible production cost.

## AMERICAN AVIATION FORCES IN FRANCE

WHEN the armistice went into effect on the western front on the morning of Nov. 11, the American Army had forty-five airplane squadrons in operation on that front. The total personnel in France at that time was 58,090, of whom 6861 were officers and 51,229 enlisted men. A total of 109 officers and 4740 enlisted men were serving with the French Army in air service mechanic regiments. On that date the flying personnel under instruction numbered 1323, divided as follows: preliminary, 126; advanced, 29; pursuit, 850; observation, 140; day bombing, 77, and night bombing, 101. At that time 563 artillery observers were in training as well as 65 day and 61 night bombing officers, a total of 689. The flying personnel awaiting instruction included 155 pilots and 59 observers.

The number of planes received from all sources by the American Expeditionary Force between Sept. 12, 1917, and Nov. 16, 1918, are grouped below by types.

Type of Plane	For Service	For Schools
Pursuit .....	3,337	90
Observation .....	3,421	664
Day bombing .....	421	85
Night reconnoissance .....	31	....
Training .....	....	2,285
Experimental .....	30	....
Miscellaneous .....	108	....
Total .....	10,472	

Eight different schools under American control were established in France and designated for training 3800 officers and 11,700 enlisted men. Schools for observers were located at Tours and Chatillon-sur-Seine, instruction in general flying was given at Issoudun, bombardment work was taught at Clermont Ferrand, aerial gunners were trained at St. Jean de Monte and instruction in observing artillery fire was given at Souge, Coetquidan and Macon.



# Possibilities of Steam Power

By J. D. NIES\* (Non-Member)

MID-WEST SECTION PAPER

**T**HIS paper is written from the point of view of an engineer not connected in any way with the automobile industry, but interested solely in the engineering problem of finding the best type of powerplant for automotive service. The paper will be limited to a discussion of such general matters as power characteristics and methods of control to the exclusion of details of construction.

By way of introduction it may be of interest to consider briefly the status of powerplants in general use at the present time.

In the stationary powerplant field steam is far in the lead. The possibility of using gas or oil engines in large electric powerplants would not receive a moment's consideration from the designer of such plants, unless local conditions were such as to make available a large supply of fuel especially adapted to such engines, and even in that case steam is the only logical choice. Oil engines and producer gas engines are possibilities in smaller plants, and the gasoline engine is supreme in very small plants of the intermittent service type.

## TRANSPORTATION

In the general field of transportation, including all kinds—water, rail, air and road—giving to each its relative importance, steam power is unquestionably supreme. Water and rail transportation, which are carried on almost entirely by steam, are of overbalancing importance as compared with transportation by airplane, motor car and motor truck. Naval vessels and large passenger vessels and freighters use steam power exclusively. Vessels requiring a moderate amount of power use steam almost exclusively, although the oil engine is gaining, very properly, a foothold in this field. Very small boats use the gasoline engine.

All long distance rail haulage is carried on by steam; electric power, which is generated in most cases from steam power, is used in cities for tunnel and terminal operation, and to some extent on mountain divisions of steam roads. The internal-combustion locomotive does not exist; probably it cannot be built, and certainly if it were built it would prove a failure, for the reason that irregularities of tractive effort, which may be condoned in a single vehicle, could not be tolerated in the haulage of long trains having enormous inertia. In the field of air transportation the gasoline engine is supreme and is almost certain to remain so, the conditions under which these powerplants operate being ideal for it.

Road transportation is carried on mainly by horses and by motor cars and trucks, to some extent by electric vehicles, and to a less extent by steam power. Whether the existing situation in this field is wholly justified is a question, since the steam engine is really much better adapted to road transportation than either the electric motor or the gasoline engine. The pressure of the fuel situation or the demand by the purchasing public for a performance unobtainable in any other way may bring about the return of the steam plant to its fitting place in this field.

In the early days car buyers were not critical of performance, but were satisfied with anything that would run; witness the eagerness with which "one-lungers," unsalable now, were bought. The early gasoline cars used less fuel than the steam cars, and there was then no cheaper fuel to which the steam car could turn. Steaming up was troublesome; trips had to be planned with reference to water supplies along the route; gages had to be watched and valves manipulated; water had to be taken where it could be found though its quality might be simply poisonous to a steam boiler; a cloud of exhaust steam followed the car; body designs were not along accepted lines; until quite recently the driver had to keep his mind on the replenishment of the water tank, two fuel tanks, the oil tank, the acetylene tank, and the storage battery. Because of these handicaps on the steam plant, the preference of the buying public for the gasoline car is easily explainable. The steam car lost possession of the field through faults that were of a temporary nature and have now in the main been eliminated.

After the choice of the gasoline engine was made, manufacturing and sales inertia continued it through the years that followed. The growing demand for gasoline cars led to quantity production, which lowered the cost and led to the concentration of many minds on improvements; both factors stimulated sales, and increased sales still further lowered costs and brought in improvements, and so on. The improvement of the steam car was very slow in comparison.

A study of the ability of the horse throws a good deal of light upon the question of comparative abilities of steam, electric and gasoline powerplants. A draft horse can exert, on good footing, a tractive effort of 1100 lb., more or less, but only for a short distance and at a low speed. The same horse, walking at 3 miles per hr., can maintain a pull of 120 lb. Speaking of the horse as we would of a motor, we would say that his starting torque is 9.5 times his running torque. The horse must, therefore, be regarded as an extremely flexible motor, capable of varying his tractive effort over a wide range in response to the constantly varying demands of the load. It is this flexibility that enables coal dealers to send out loads of coal weighing 4 tons net behind a two-horse team, a total weight including the "motor" of 12,000 lb., something no one would dream of doing with a 2-hp. motor truck. It should be remembered also that the horse is not aided by any gear-changing mechanism, but goes every inch of the way on "high gear."

A race horse is entitled to a power rating of about 0.75 hp. on continuous load, but can carry himself and a jockey, a total weight of some 1100 lb., at a speed approaching 40 miles per hr. for a short time, developing under this condition probably ten times his rated power. We would not expect a 0.75-hp. runabout weighing 1100 lb. to make 40 miles per hr.

The performance of draft and race horses indicates what can be done with a small amount of power provided the powerplant has flexibility; by flexibility is meant the ability to increase tractive effort at expense of speed or speed at expense of tractive effort, and to take an over-

\*Lewis Institute of Technology, Chicago, Ill.

## POSSIBILITIES OF STEAM POWER

171

load. The extent to which any powerplant possesses this flexibility is the measure of its suitability to automotive work.

Flexibility of this desirable type is possessed in fullest measure by the steam engine, to a less extent by the electric motor, and not at all by the gasoline engine. Its possession by the steam engine enables a steam plant of moderate power to take the place of and show better performance than a plant of much larger power in which that flexibility is lacking. A steam car rated at 20 hp. will usually have little difficulty on the road in getting the better of an argument with a 70 or 80 hp. gasoline car, although the latter would win on the speedway. That is because the power is under the driver's control in the one car, and is not under his control but rather under the engine's control in the other. The steam car driver can throw the full power of his plant into acceleration on hill climbing if he likes, at any time and at any speed, but the gasoline car driver is rigidly limited to the use of whatever fraction of the full power his engine can develop at the existing speed.

The driver of the gasoline car practically never has the use of the car's maximum power. The average speed of a car throughout its life is probably about 17.5 miles per hr. At that speed the engine of the best known light car can develop about 9 hp., and that amount of power is all that the driver has the use of, on the average. Among heavy cars, a certain car with an eight-cylinder 3.125 by 5.125-in. engine can apply to the drive wheels only about 19 hp. at the assumed average speed of use; therefore 19 hp. is the average amount of power available to the driver of that car, although the given powerplant can develop 70 hp. if the speed be high enough.

## STEAM VERSUS GASOLINE

It will be interesting to compare the performance of the above mentioned eight-cylinder car with that of a steam car of half the maximum power, taking the maximum continuous output at 70 hp. for the gasoline car and 35

for its ability to store up energy in the boiler during periods of light load for release during periods of heavy load. But even so, steam makes much the better showing, good performance being infinitely more desirable through the range of speed from 30 miles down than from 30 miles up. At the average running speed, the steam plant renders available double the power of the gasoline plant, and that with a plant of half the ultimate power.

If we take into account the feature of storage of energy, the showing of the steam car is really much better than as represented in the table. There is enough heat in the boiler to drive the car some 2 miles on smooth level road without assistance from the burner; a heavier tractive effort can be maintained over a less distance; for a short distance the stored energy can maintain a tractive effort limited only by the slipping of the drive wheels. This tremendous supply of stored energy can be released at will, being added to that developed by the burner, the only restriction being that the period of such use is followed by a period of moderate use, during which the steam pressure can be recovered. It is rather a striking fact that the steam car can climb a hill on energy put into the boiler during the descent of some other hill possibly several miles back along the road.

This ability to store energy enables the steam plant to take advantage of the irregularity or diversity factor of the load, thus enabling the boiler to work at an average rate much lower than the maximum demand. For instance, if the car were driven under conditions such that the engine did little or no work half of the time in short periods, it could develop double the normal rating during the other half. Thus a 35-hp. plant would take an equivalent rating of 70 hp. This works out in actual running to a sufficient extent to entitle the steam plant to a decided revision, in its favor, of the value given in the accompanying table of performance.

Of course, on long grades the storage of energy ceases to be an important factor. If the gradient is such as to permit the gasoline car to maintain a speed in excess of

Speed, miles per hr.	Necessary hp.	Gasoline		Steam Hp.	Steam Reserve	Advantage	
		Hp.	Reserve			Gasoline	Steam
60	42.0	66.0	24.0	35.0	0.0	unlimited	.....
50	29.3	59.0	29.7	35.0	5.7	5.2 to 1	.....
40	19.6	49.0	29.4	35.0	15.4	1.9 to 1	.....
30	12.5	35.0	22.5	35.0	22.5	none	none
20	7.3	22.0	14.3	35.0	27.7	.....	1.93 to 1
10	3.3	8.0	4.7	27*	23.7	.....	5 to 1
5	1.6	1.6	0.0	13.5*	11.9	.....	unlimited
0	0.0	0.0	0.0	maximum torque		.....	unlimited

\*This is all the power the drive wheels can utilize without slipping.

hp. for the steam car. An allowance of 5 per cent may properly be made for transmission loss in the gasoline car. The comparison is tabulated above; the values in the second column are the powers necessary to keep the car moving steadily on smooth level road, based on 120 lb. towing resistance, and 10 sq. ft. of front area and wind resistance derived from U. S. Signal values; the third column gives power available at the rear wheels of the gasoline car with wide throttle on high gear; the fourth column gives the gasoline car's reserve of power available for acceleration or hill climbing; the fifth and sixth columns give corresponding figures for the steam car; the last two columns give the comparative advantage of each plant.

In two ways the basis of this comparison is unfair to steam; the steam plant is taken as half as large as the gasoline plant, and no credit is given to the steam plant

30 miles per hr. it will overtake and pass the steam car if the grade be long enough, although the steam car would take the lead at the start. But if the grade does not allow the 70-hp. gasoline car to maintain a 30-mile speed, the 35-hp. steam car will improve its lead all the way to the top.

## STEAM VERSUS ELECTRICITY

Steam and electricity are not regarded as competitors in automotive service, nevertheless a brief comparison of them may be of interest. The electric plant is simple, and is easy to control. It is limited as to mileage and speed, and must be idle at frequent intervals for charging. Of the two plants the steam one is far more flexible. It is easier to control the flow of steam to an engine than to control the flow of electric current to a motor, just as it is easier to turn a gas jet up or down than to turn an

electric lamp up or down—the latter cannot be done by any simple means. The steam car can be throttled down to any speed, however low, and will continue to run with full positiveness and with nearly full economy; it can “stand against the load” without consuming steam, by static pressure in the cylinders. But if an electric car is reduced in speed say from 25 miles to 1 mile on full torque by rheostat, the control lacks positiveness, since an increase of some 8 per cent in the demand for torque from the motor will cause the car to stop; if the control is half by battery and half by rheostat, a 15 per cent increase in torque demand will stop the car; in the former case 96 per cent, in the latter 93 per cent, of the energy drawn from the battery is wasted. The electric motor cannot stand against the load without consuming just as much current as is required for running against the same torque load.

If some form of electric control of a simple nature could be devised that would take 10 amp. at 88 volts from the battery and convert it to 20 amp. at 44 volts or 40 amp. at 22 volts or 100 amp. at 8.8 volts or into any other two values giving a constant product of 880, and could make the changes without breaks or steps, it would measure up to the standard of control afforded by the steam throttle. The thing cannot be done.

Throttle control, the sole means used in a steam plant, presents several technical aspects deserving of consideration. Steam passing through a throttle loses no heat, gains entropy, receives superheat, loses pressure, and gains volume almost in the same ratio that it loses pressure. What is lost in pressure is gained in volume; in other words, throttling reduces the tractive effort but increases the distance a given quantity of steam will drive the car; thus a given weight of steam can be used to give a large tractive effort for a short distance or a small tractive effort for a long distance, or anything between these extremes. The throttle is the steam plant's equivalent of the gearbox.

The action of the throttle may be illustrated by a concrete example, based on a two-cylinder 4 by 5-in. engine with 5 per cent clearance and 100 lb. compression, operating at quarter stroke cut-off on 600-lb. boiler pressure. Assume the steam to be throttled from 600 to 100 lb. gage. Then the tractive effort is reduced from 750 to 104 lb., or 7.2 to 1; the steam volume is increased from 0.74 to 4.22 cu. ft., or 1 to 5.7; the strokes per pound are increased from 71 to 500, or 1 to 7; the steam is superheated 38 deg.

The given throttling thus divides the tractive effort by 7.2 but multiplies the distance traveled per pound of steam by 7, an effect like that accomplished in a gasoline car by making a 7 to 1 change in the gear ratio.

The steam throttle is always set by the driver, unconsciously, at the position which gives the engine the least possible pressure that will drive the car, and this results in the steam gaining the largest possible increase in volume through the throttle; the steam is therefore always used in the most advantageous way. The effect is similar to what would be obtained in a gasoline car if the speed of the latter were held down, not by spark or throttle, but by shifting gears so as to get the largest possible number of revolutions of the drive wheels per revolution of the engine. Every position of the steam throttle is the counterpart of some particular gear ratio in the gasoline car; every movement of the throttle corresponds to a change in the gear ratio; full opening of the steam throttle at quarter stroke cut-off corresponds to a gear ratio of about 7.5 to 1 between engine and rear

wheels in the case of the eight-cylinder car mentioned above; complete closure of the throttle is the equivalent of shifting to a gear of such low ratio that the engine cannot run.

#### STEAM THROTTLE VERSUS GEARBOX

The throttle is an improvement over the gearbox in these particulars:

(a) The throttle requires negligible manual effort for its operation.

(b) The throttle gives the equivalent of an infinite number of gear ratios, instead of three or four.

(c) The whole range of changes can be swept through instantly with the throttle.

(d) Changes can be made at any speed.

(e) Throttle control gives the effect of a gear shift but without modifying the relation between engine speed and car speed, that is, opening the steam throttle gives an increase of tractive effort which in the gasoline car is obtained by an increase of engine speed.

(f) The setting of the throttle by the driver is always equivalent to the selection of the one particular gear ratio, out of an infinite number, that is best suited to do the work of the moment.

(g) Much less energy is lost in the steam throttle than in the gearbox.

With the assumed steam plant a 20-mile speed on smooth level road is obtainable with a throttle position that gives the engine a pressure of a little over 100 lb. Assume that the car when so running is sent up a grade without the throttle being touched. On the grade the car will slow down, but will not stop; as the engine slows down it takes steam away from the throttle at a lower rate, the pressure in the cylinders rises; and the tractive effort increases, this increase continuing automatically until the tractive effort is sufficient for the grade. Before the car would stop, the pressure in the cylinders would rise practically to boiler pressure and the tractive effort at quarter stroke cut-off would attain a value about double that obtainable from the comparable gasoline car on direct drive.

To duplicate this effect, the gasoline car would require a gearbox with an infinite number of gear ratios, the gears in which change themselves, without the driver's knowledge, without noise and without interruptions of torque, to successively higher ratios until a ratio is reached that is just right for the grade.

Any throttling process is thermodynamically irreversible and is attended by a loss of available energy. The amount of such loss is, however, much less than is generally supposed, and there are certain compensating factors that reduce the loss in practice nearly to zero. A working pressure, say of 150 lb., with strongly superheated steam, will give better economy in a simple engine than will a pressure of 600 lb.; and this improved economy at the reduced pressure offsets the loss due to throttling. At reduced pressure there is less loss in the clearance and less at the release, besides less loss by cylinder condensation, due to the lower temperature and higher superheat of the steam entering the engine. It is shown above that when throttling from 600 to 100 lb. the reduction of tractive effort is in the ratio 7.2 to 1, but the increase in travel is in the ratio 1 to 7, indicating a loss of only 2.8 per cent. The calculation is based on ideal indicator cards but is undoubtedly closely approximated in practice.

A boiler pressure of 600 lb. is used only because it increases the range of throttle control. Assume that the car can be moved by a pressure of about 100 lb. on the

engine; then if the boiler pressure were, say, 200 lb., the tractive effort could be doubled only by opening the throttle wide, but with 600 lb. it could be increased seven-fold; in the same way it could be increased fifteen-fold if the boiler pressure were 1200 lb., but so great an increase is unnecessary. The seven-fold increase available with 600 lb. is sufficient for all ordinary running, but if more tractive effort is wanted it can be obtained by lengthening the cut-off, which gives a tractive effort much beyond the slipping point of the drive wheels on dry road.

There is no objection to the use of high pressure on the score of additional heat needed to make steam or higher temperature of the steam; steam at 600 lb. requires only 5.9 B.t.u. more and is only 69.1 deg. hotter than steam at 300 lb. The loss due to increased temperature of the waste gases is only a few per cent.

The pressure maintained on the engine in ordinary driving is 200 lb. or less, occasionally rising above this value, but hardly ever going up to the full boiler pressure. The throttle is practically never open wide.

The size of the boiler has no effect on the tractive effort but fixes the speed at which any particular tractive effort can be maintained. Reducing the size of the boiler reduces cost and weight and heat storage, but makes no great difference in the time required to steam up, since the smaller boiler has a smaller burner. The tendency has been to use smaller boilers, since that has no bad effect upon performance at the usual running speeds, and there is a growing appreciation of the uselessness of very high speeds. The maximum speed attainable by a car depends almost entirely upon the size of the boiler, but the maximum attainable tractive effort depends upon the bore and stroke of the engine and the gear ratio, and is independent of the size of the boiler.

Scale formations were inevitable in the early cars because much raw water was taken on, and because it had to be taken where it could be found regardless of hardness. At the present time only about one-tenth of the former amount of raw water is taken on, and that little can practically all be taken on at home, enabling the operator to use soft water if he desires. With soft water there is no scale.

The steam car uses fuel almost exactly in accordance with the tractive effort it has to develop. The thermal efficiency of the gasoline engine at full load is about

double that of the steam plant; at fractional loads, however, the mechanical efficiency of the gasoline engine falls off; at low speeds it takes as much energy to run the engine as to run the car, and there is a large loss due to throttling; the gasoline engine cannot be worked as close to its rated power as the steam engine. These factors reduce its efficiency to a point of substantial equality with that of the steam plant. At high speeds the gasoline engine has a decided advantage, but at moderate speeds the advantage is equalized or may go to steam.

#### FUTURE DEVELOPMENT

It is unquestionably true that the leading difficulties of the steam car have been overcome at the present time; in view of this, its appeal of unmatched performance may bring it back into favor, but it would be rash to make any such prediction at this time. A considerable extension of steam in this field may be confidently expected. Certain improvements are likely to be made. Means should be found to prevent such minor damage as results from a freeze-up. The whole water system should be arranged to drain from a single point. It is not too much to expect that some day a car owner will be able to press a button in his house and find steam up by the time he gets out to the garage.

Instantaneous raising of steam will never be realized, although the time required to steam up may be made very short. Energy is put into storage during the steaming-up process; if one wants to secure the advantages of stored energy on the road he must be willing to store it before starting out. One of the good points of the gasoline engine is that its starting requires only such storage of energy as is involved in the putting of compression into one or two cylinders; but this is also the gasoline car's leading bad point, since that small amount of stored energy is all that the driver has the use of on the road. The reasonable driver will be willing to spend a few minutes in the steaming-up process for the sake of comfort when driving.

It is possible that some day manufacturers of high-grade cars will come to regard the hopelessly defective power-characteristic of the gasoline engine as being a flaw in their product no more to be tolerated than poor material or bad workmanship.

## USING THE MOTOR CAR IN JAPAN

THE regulations governing motor vehicles in the city of Pyang Yang, Chosen, as sent out by the police authorities in 1917, are reproduced below:

(1) You must drive your automobile at the speed of 8 knots per hr. on the city roads and 12 knots per hr. on the country roads.

(2) In narrow place of road, corner and bridge speed slowly.

(3) When you see the policeman throwing up his hand you must not drive in front of him.

(4) When you pass the corner and the bridge ring the horn.

(5) When you get ahead of the passenger on foot or the cow or the horse you must ring the horn.

(6) When you meet the horse or the cow speed slowly and take care to ring the horn and not be afraid of them. Drive slowly when you meet the horse and the cattle, do not make them afraid and carefully make the sound. If they afraid the sound you must escape a little while at the side of the road till they pass away.

(7) When you drive the motor car do not leave the driver seat and take care lest unexpected trouble happen.

(8) Do not drive the motor car when you get drunk and do not smoke on the driver seat.

(9) When two cars are driving in the same road, if there is another car in front of yours or behind yours you must keep 60 yd. away from him; if you go ahead of him ring horn and pass him.

(10) When you cross the railway wait until the other train and other cars pass through.

(11) When anything the matter with your car you go to the police station and tell him.

(12) When you want to have a driver or exchange another, you must enclose driver's address, career and age.

#### SPECIAL NOTICE

You must never put overload on your automobile. The licensed capacity of your Ford car is five persons, two in front house and three back house.

# Motor Truck Chassis Design

By CORNELIUS T. MYERS\* (Member)

SOCIETY TRUCK MEETING PAPER

Illustrated with CHARTS AND DRAWINGS

A PERIOD of great stress in the motor truck industry has just passed. A vast demand for its product arose. The trucks themselves have magnificently filled a colossal and distressing need, and the industry has met the demand with a 100 per cent response. The performance of our motor trucks has been one of great merit. Tried under the hard service of war-time necessity, they have reflected credit upon our industry and have established a world-wide reputation for it. True, there have been faults in design and weaknesses of construction that were brought out from time to time. Most of these developed from a service more strenuous than that for which the trucks were originally designed, but the proper recognition of these deficiencies will serve as a guide for the present and future.

With the United States at last taking part in world affairs, and considering the foreign service of our motor trucks, it is quite reasonable that the energetic American truck manufacturer should look abroad for a considerable foreign business. He will get it, beyond a doubt. I have recently talked with a number of men well acquainted with foreign demand and competition in motor trucks. They have all said that there was an undoubted opportunity for us to get well established abroad, but almost invariably have questioned one or more details in connection with the particular truck or trucks under discussion. Some of these men were the heads of export houses, others in export organizations of standing. In their case the cost of an initial sale in distant countries often exceeds not only the nominal profit but the invoice itself, and the profit comes from the repeat orders of satisfied customers. These exporters were chiefly concerned with the attention paid to details of design, since the trucks go far beyond the reach of factory or service station. This brings us back to the very comforting reflection that our general types of chassis are correct.

## WHAT GOOD DESIGN REQUIRES

In the progress of development we have seen practically all types give way to the truck with a four-cylinder four-cycle engine mounted near the front of the frame and just back of a built-up radiator, the driver's seat behind the engine, a selective controlled three or four speed gearbox, a propeller shaft with two or more universal joints and a rear axle with an enclosed drive. This type became popular because of the comparative accessibility of all its parts. While reliability is the first requisite of a motor truck, accessibility is a close second; so when the component parts of the chassis were in a state of development and needed considerable attention, the type of chassis design that afforded ready access to the various units or parts thereof was bound to prevail. Now that unit reliability has been better established we shall likely see more modifications of the prevailing type.

The second requisite of a motor truck, the accessibility of its parts, is no mean qualification. Many an offending part has been condoned because of its ease of adjustment or renewal, and many a truck-hour has been saved

by the owner on this account. Whether detail parts are nearly enough perfect for us to compromise their accessibility is a matter for nice judgment. Even though average performance is good, the chance of accident must be carefully considered. Major units should be so assembled that each can be taken down for repairs with the least disturbance of other parts or units. Fastenings should be not too complicated or too close fitting. Hours of time are lost in the service station, garage or repair shop due to small shortcomings under this head.

As the third requisite I shall put down simplicity. The fewer parts there are on a motor truck chassis, and still have it function properly, the better it is for the owner, the driver and the manufacturer. There are so few parts on a chassis that do not demand attention at one time or another that any absolutely unessential thing is a detriment, however pleasing it may look on the sales-room floor.

A well-known operator of many trucks in New York told me that as often as a new chassis was delivered to him he personally made an inspection to see what he could remove from it. He invariably found quite a collection of troublesome stuff which he sold to other users of the same model who felt that these should continuously be a part of their truck's equipment. An attachment added to an unsatisfactory device to make it function better is a poor substitute for a more satisfactory device. The fewer parts there are on a chassis the more accessible are the other parts and the more wrench clearance is available. This matter of wrench clearance is much appreciated by the repair man and helps to sell trucks.

Fourth in order of importance I should put weight. The more weight we add to a given chassis the less becomes its pay load capacity. Of course it is quite possible to lighten parts to the extent that they are too weak to function properly; but on the other hand careful study and analysis will reveal ways of reducing the weight of a chassis without affecting its serviceability. Every pound removed from the chassis adds a pound to the load carrying ability of the truck, or calls for less power in driving and less wear and tear on the tires. Weight reduction also affects speed, as is mentioned later.

Fifth on my list is operating economy—pertaining to fuel, tires, repairs and the nervous energy of the driver. We have a big problem before us as regards fuel consumption, and from the opinions of well-known authorities the situation bids fair to become worse, and in the immediate future. We are not today doing nearly the best we can with the fuels we have.

Fig. 2 illustrates the estimated petroleum reserve in the United States and the increasing rate at which it is being consumed. Other sources are problematical and not immediately available.

Fig. 3 shows the great and rapidly increasing demand on the fuel supply made by the motor truck, and the alarmingly small increase in fuel production to meet it. This surely means a shortage and increase in fuel price, and indicates the importance of fully considering chassis design from the standpoint of fuel economy. One phase

\*Consulting engineer, Avenel, N. J.

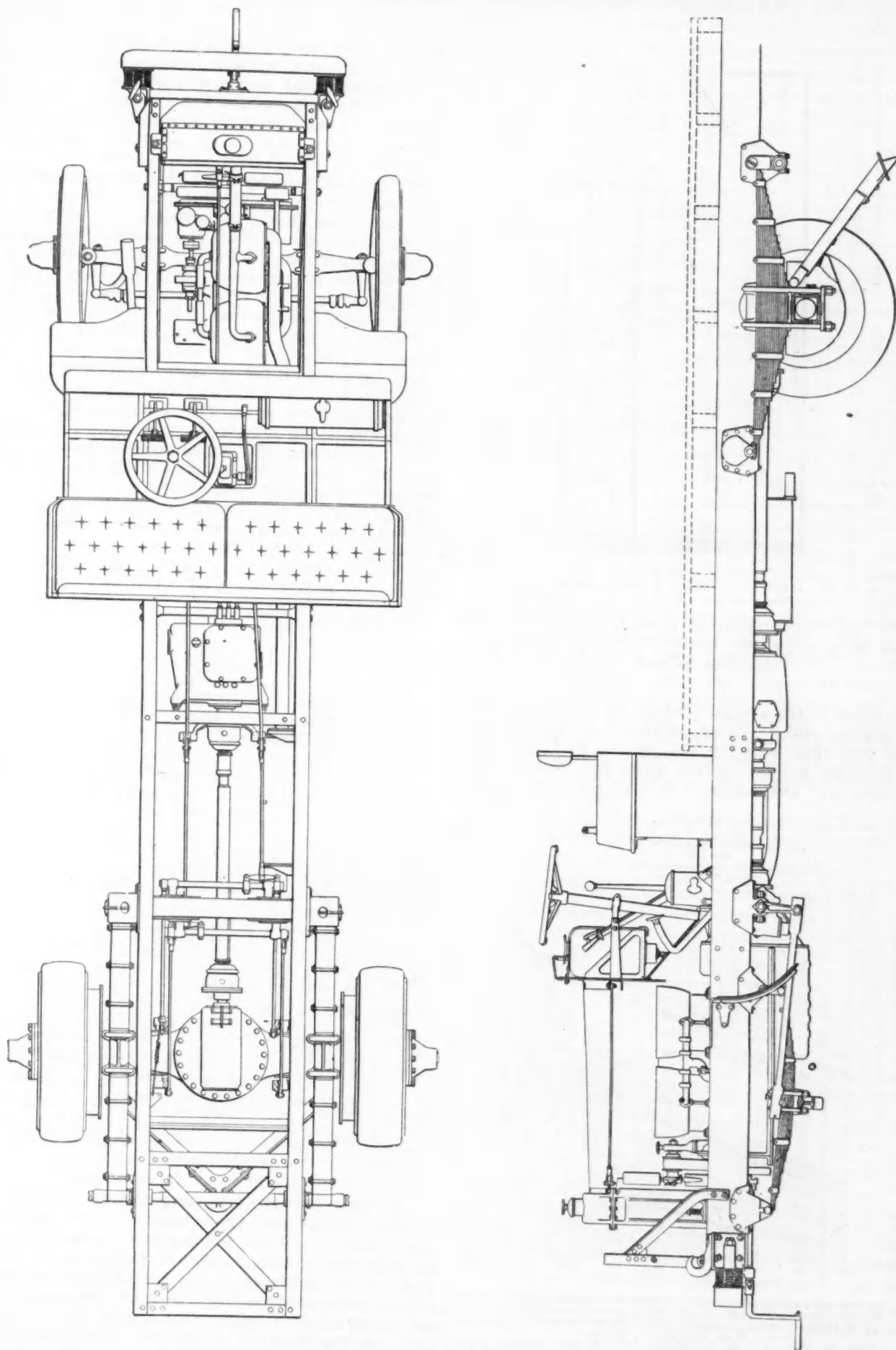


FIG. 1—PLAN AND ELEVATION OF THE CLASS B UNITED STATES MILITARY TRUCK

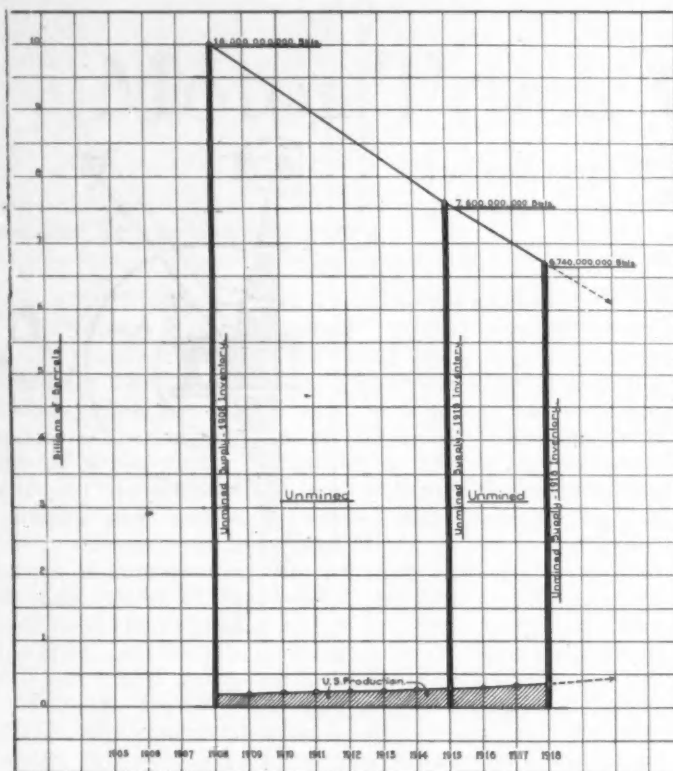


FIG. 2—THE DOMESTIC CRUDE PETROLEUM SITUATION FROM DATA COMPILED BY THE U. S. GEOLOGICAL SURVEY (From a paper entitled "An Interpretation of the Engine Fuel Situation," presented by Joseph E. Pogue at the 1919 Annual Meeting of the Society)

of this concerns the average load on the engine. Motor truck engines under average service conditions do not operate with ideal economy even at full load; but how often do these engines operate under full load or anywhere near it? The engine in the average truck of less

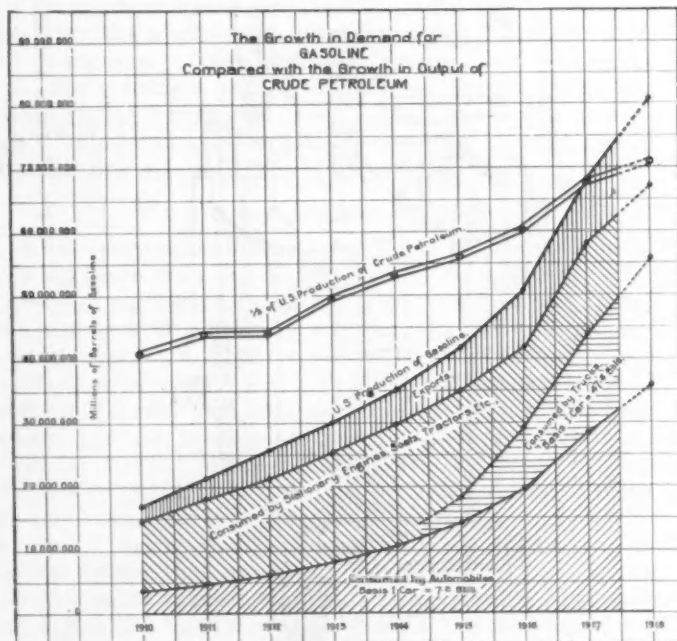


FIG. 3—CHART OF THE GASOLINE SITUATION FROM DATA SUPPLIED BY THE U. S. GEOLOGICAL SURVEY, U. S. FUEL ADMINISTRATION, U. S. BUREAU OF MINES, NATIONAL AUTOMOBILE CHAMBER OF COMMERCE AND THE WAR INDUSTRIES BOARD (From a paper entitled "An Interpretation of the Engine Fuel Situation," presented by Joseph E. Pogue at the 1919 Annual Meeting of the Society)

than  $2\frac{1}{2}$ -tons capacity operates at about 20 per cent of full load when the truck is carrying its capacity load; larger trucks load the engine a little more heavily. When the truck is running light, or but partially loaded the engine is called upon for only 12 to 15 per cent of its full load torque. Let us see what this means in fuel economy.

In Fig. 4 it is brought out that an engine at 15 per cent load is much less efficient than at 25 per cent and uses approximately 35 per cent more fuel. Fig. 5 shows a wider range of conditions and confirms this statement.

An even more fruitful field for saving, however, is that of carburetor adjustment. There are many truck carburetors that give the driver, a man without knowledge of the theory and practice of burning fuel in internal-combustion engines, the power to upset to a considerable degree the fuel economy we reasonably expect to obtain. He can tamper with the carburetor and almost invariably he will misadjust it. Not only does this result in a very considerable increase in the amount of gasoline consumed, but it can arbitrarily reduce the torque of the engine, overburden the cooling system, foul the spark-plugs and cause serious delays and expense due to carbonization of cylinders and dilution of crankcase oil.

Fig. 6 illustrates an average condition vouched for by the Bureau of Standards and typical of a large number of trucks. It is interesting to compare these curves with the ones referred to previously. The possibilities of saving fuel become distinctly apparent. Fig. 7 brings

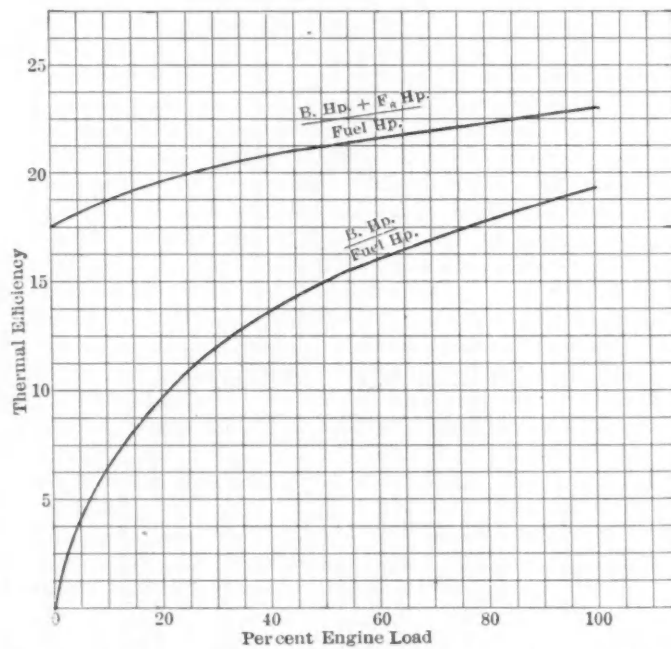


FIG. 4—CURVE OF THE THERMAL EFFICIENCY OF A CLASS B TRUCK ENGINE OPERATING AT 1000 R.P.M. AT VARIOUS PERCENTAGES OF LOAD (From a paper entitled "Fuel Economy of Automotive Engines," presented by Dr. H. C. Dickinson at the 1919 Annual Meeting of the Society)

out the same conditions converted into miles per gallon—a more familiar term to the owner. If we decrease the speed scale by one-half and double the consumption scale we shall have a diagram that represents truck performance. I can testify to raising the gasoline mileage of a certain model of 2-ton truck from an average of 6 miles per gal. to almost 11 miles without sacrificing the pulling ability or the flexibility in any way—bettering them, in fact.

## MOTOR TRUCK CHASSIS DESIGN

177

The cost of tires is a large item in motor truck operation. It can be materially decreased by reducing total and unsprung weights, and bettering spring suspension. In some instances tires are too small for the truck. There has been some tendency to apply narrower tires to save in first cost.

The driver's comfort has a good bit to do with the service rendered by the truck. We must therefore have

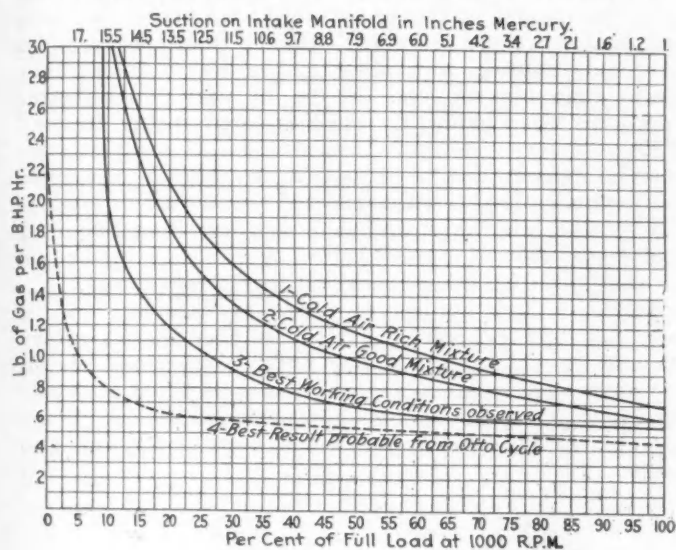


FIG. 5—FUEL ECONOMY OF DIFFERENT INTERNAL-COMBUSTION ENGINES AT VARIOUS PERCENTAGES OF LOAD AVERAGED FROM A NUMBER OF TESTS (From a paper entitled "The Principles of the Wheeled Farm Tractor," presented by Edward R. Hewitt at the 1919 Annual Meeting of the Society)

good springs, easy seats, well arranged controls, protection from inclement weather and the minimum of details that require attention and care.

A careful and capable handling of the previously mentioned features will bring about a design of chassis that will permit of a high average speed. We can haul as heavy loads with horses or mules as with trucks, but the great advantage the truck possesses over animal-drawn vehicles is that of speed. How fast can the load be delivered and a return made for the next load? The perfecting of the "giant" pneumatic tire has made possible a considerable increase in maximum speed, and we are bound to see this possibility developed. With the considerable increase of speed more attention will have to be paid to brakes and steering mechanism. However, it is the average speed that counts—not the maximum speed. A safe increase in maximum speed helps the average, especially on long hauls. But a far more important feature than maximum speed is that of keeping the trucks moving—no wasted time in roadside adjustments or repairs, or in the repair shop, or due to the neglect of some inaccessible part, to accidents resulting from an overtired driver, to expensive overhaul, or to failure of small details, which receive less design attention than they deserve on account of the large amount of thought and energy expended on main units.

The last general point upon which I shall touch is cost. Here it is more important to consider the cost of transportation by motor truck than the cost of the truck itself. The purchaser is only incidentally interested in the size and type of the various structural features entering into the composition of the chassis. What he wants is a piece of mechanism that will carry his goods for the lowest net cost and cause him the least worry. If manu-

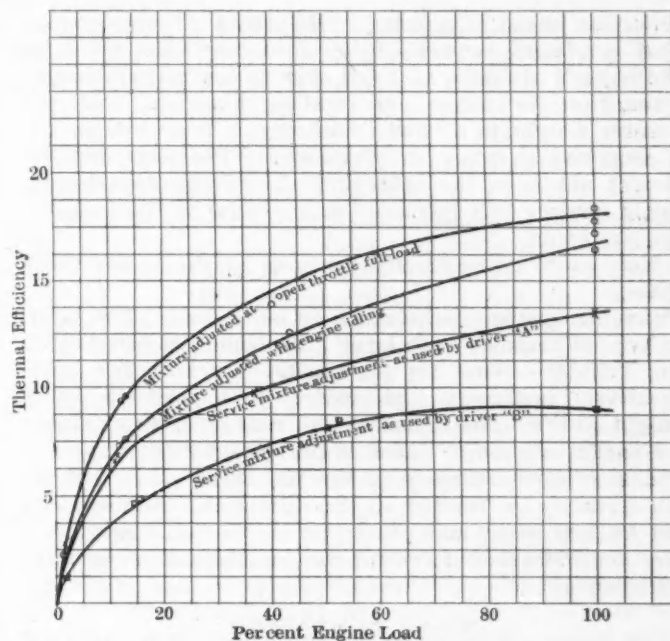


FIG. 6—THE THERMAL EFFICIENCY OF A FORD ENGINE EQUIPPED WITH A STANDARD CARBURETOR AND USING DIFFERENT MIXTURE ADJUSTMENTS AT VARIOUS PERCENTAGES OF LOAD (From a paper entitled "Fuel Economy of Automotive Engines," presented by Dr. H. C. Dickinson at the 1919 Annual Meeting of the Society)

facturing costs are reduced at the expense of any of the vital features of the truck, it is worth less to the buyer, and, in the course of time, he will discover it. One thing that some of our war work has done is to show how small a difference in cost exists between a thing well done and one nearly well done. If this lesson is heeded, if simplification is properly carried out, and the designs drawn so that some parts can perform a double, or sometimes even a triple, function, very considerable cost reductions can be made.

In a paper delivered recently before the Society the chief engineer of one of our large concerns placed cost

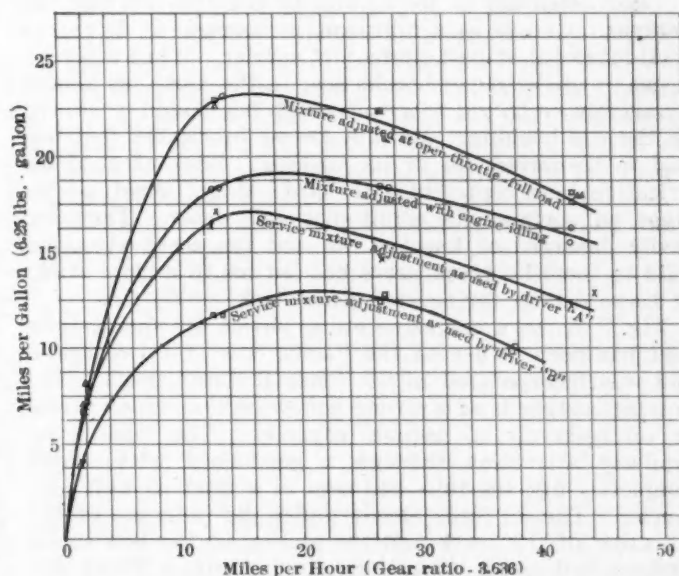


FIG. 7—CURVE SHOWING THE RELATION BETWEEN THE SPEED OF A FORD CAR EQUIPPED WITH A STANDARD CARBURETOR AND USING DIFFERENT MIXTURES AND THE MILEAGE OBTAINED FROM A GALLON OF FUEL (From a paper entitled "Fuel Economy of Automotive Engines," presented by Dr. H. C. Dickinson at the 1919 Annual Meeting of the Society)

reduction ahead of economy. He stated, "I must confess that in placing economy below first cost I am reflecting the buyer's attitude, as he, thanks to the manufacturer's reputation for never understating his case, will give greater weight to a known economy of first cost than to a promised economy in operation." Possibly more restraint put upon the sales and advertising departments would obviate this attitude—detrimental to the industry and the trade.

Now as to more specific features of the motor truck chassis.

Cooling systems leave much to be desired. The built-up type of radiator with large gilled tubes, is very sturdy and reliable—hence its popularity. It is bulky, comparatively inefficient, and costly. It imposes its extra weight on the frame ahead of the front axle, which makes for harder steering. Much improvement in average fan efficiency has been made in the last three years, but we can certainly go further in this direction. Fan location can be improved, and altogether I am satisfied that a very considerable betterment can be effected in our cooling systems.

#### SPRING SUSPENSIONS

Spring suspensions have improved, but still offer a large field for advancement. The fact that they serve as buffers for the whole chassis above them, and that the life of the chassis parts is largely dependent upon the efficiency with which they function, warrants very careful study of everything pertaining to the spring suspension. The life of tires, also, will be favorably affected by good springing. Longer springs, flat under load, are being generally adopted. We have not yet got the spring that will give us a much higher rate of deflection at light load than at full load. Some commendable efforts in this direction are being made, however, and the results will be watched with much interest. Springs which receive enough oil to keep the leaves from rusting and accumulating an excessive amount of interleaf friction have a considerable advantage, and the rapid increase in the use of oil as a spring-bolt lubricant will increase spring effectiveness.

Close attention to spring-bolt lubrication will pay big returns. Grease as a lubricant is doomed—it is only a semi-lubricant at best, and a dirt carrier. When a spring opens up at the eye or breaks near it, the cause can almost invariably be traced to a bolt which has bound or chafed in the eye bushing. Many a grease lubricated bolt has had to be driven out of its bushing. Lack of good lubrication here contributes to hard riding. Most oil fittings on spring-bolts admit dirt and water. They are easily damaged or knocked off, and the scant attention paid to them by truck users has led me to a close study of these details for several years back.

Fig. 8 shows a magazine oiling device for spring-bolts that has been in use on the Pacific coast for two years, and was incorporated in the Class B Army truck. The bracket casting is of a strong hollow section which forms an oil reservoir of unusual capacity. The feed is by capillary attraction through a good-sized wick which completely fills the tube and acts as a filter as well as a carrier. The oil feeds slowly under the influence of the vibration of the truck and the motion of the bolt in its bushing and ceases when these stop. A single filling will last from one to three months. Dirt and water cannot be fed to the bolt. It eliminates small oil cups which are continually being damaged, and considerably reduces the attention required. The small surplus of oil flows down the spring leaves and keeps them easy and free from

rust. In Fig. 9 the rear shackle is made hollow for the oil and is very strong, due to the box section; yet it is not clumsy looking and entails no extra machining except tapping the hole for the filler plug.

We have all been looking for a means of determining how good springs are. I quote from a letter which shows the value of good springs in a certain kind of service: "Packing houses in the fruit and vegetable district pay owners of trucks equipped with magazine oiling one cent more per crate for delivery than they pay for the same hauling with other makes of trucks, as they claim that berries, etc., arrive in very much better condition when hauled by the lubricated spring trucks." This is a very practical demonstration of a direct commercial benefit due to attention to detail. A certain trade publication recently reported that a fleet of twenty-five trucks, similarly equipped, and handling ore over bad roads, showed a much better tire mileage than could be obtained with other trucks on this same service.

While on this subject of oiling of chassis parts, it may be well to call attention to the unsatisfactory manner in which most of our brake connections are lubricated. The effectiveness of brakes is often seriously impaired by the undue amount of friction almost always present in the connections, which wear badly and also rattle.

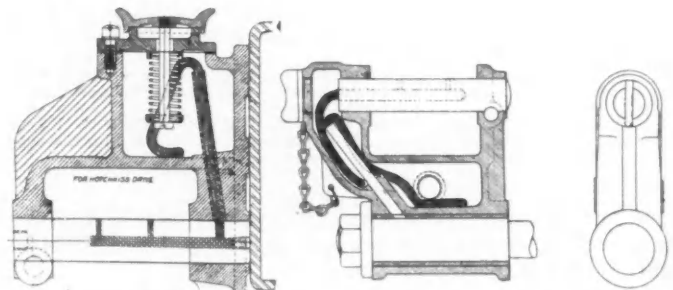


FIG. 8  
FIG. 9  
TWO EXAMPLES OF OILING DEVICES FOR SPRING BOLTS

The rocker shafts of the Class B truck were lubricated by the magazine wick system. As a rule not only is little provision made for lubricating these points, but they are so inaccessible that they get practically no attention. This feature of inaccessibility also applies to the rear axle brake parts, and a very considerable improvement can be looked for there. These should be magazine-fed so as to compensate for the lack of attention they receive.

The use of oil on front axle pins and on drag links is rapidly becoming general, as it should. There is room for improvement in detail here. A device for lubricating a universal joint by a small amount of oil drawn automatically from the gearbox or rear axle, has been proposed and is being developed. It also feeds to the slip joint in the propeller shaft where it is of great service in helping to eliminate the heavy thrusts against the bearings forward of the universal joint.

The New York branch of one of our large truck companies has established a school for training drivers, and this school lays especial emphasis on lubrication. Every man attending is given an oil can and goes over and over the chassis until he has thoroughly learned the position of every oil cup, etc. Many a poor chassis that has been well lubricated by its driver has out-served better ones that were poorly lubricated or scarcely lubricated at all. I believe we can profitably keep before us the fact that practically all mechanisms depend upon a lubricant for proper functioning. The more automatic the lubricating

## MOTOR TRUCK CHASSIS DESIGN

179

means have become, the more successful and fool-proof have our mechanisms become.

In the matter of axles and wheels we have achieved great reliability at the expense of additions in unsprung weight. As a result tires have suffered. There is need for improvement in methods of fastening springs to axles. At present there seems to be a serious need of larger spring clips than are being used and better methods of keeping clip nuts tight. Much spring breakage can be traced to loose clips. Steel wheels for 3 to 5-ton trucks are making considerable progress, due probably to a scarcity of first-class wood for felloes. Steel wheels will be lighter, we hope, as time goes on, and wood wheels of better quality.

Gearbox design is in general pretty well standardized. However, the call for boxes having a ratio of high gear to low gear in excess of 4 to 1 is being heeded. I can remember laying out a chassis back in 1911 and incorporating a four speed box in which the low-gear reduction was  $5\frac{1}{4}$  times the high gear. Two large builders of such units looked over the designs but could not see the necessity either for four speeds or for the large speed range; about 3.6 to 1 then being thought to be the correct range. The testimony given in many conferences on the Class B gearbox design and the splendid low-gear performance of these trucks, which had a speed range of about 6 to 1, has made apparent the value of the big range, and there is a rather general movement to take advantage of it.

## ENGINE SIZE

Engine size cannot be considered without due thought being given to several other important characteristics. The horsepower necessary to drive a truck at a given speed being about in proportion to the total weight moved, it will readily be seen how important is any reduction in chassis weight. In treating of engine size the torque and maximum advisable rotative speed are the two important factors to be considered. With these must be correlated the various gear reductions, the diameter of the driving tires and the total weight moved. Six years ago and twice subsequently papers were read before this Society in which was given a tractive factor formula embodying these relations. Comparisons of American and French trucks were made, and specific applications of this formula were given. The substance of this formula was embodied in the specifications of the Quartermaster General's Office of the Army, now the Motor Transport Corps, covering Class A and Class B trucks. This formula can be written in two ways:

$$TF = \frac{\text{Engine Torque} \times R}{\frac{1}{2} D \times W} \times E_t, \text{ or}$$

$$TF = \frac{8.4 n b^2 s R}{D \times W} \times E_m \times E_t$$

in which  $R$  = gear reduction

$D$  = diameter of driving tires in inches

$W$  = total weight in pounds

$E_m$  = ratio of torque developed by engine at 1000 ft. per min. piston speed, to the torque corresponding to the A. L. A. M. (N. A. C. C.) horsepower rating of the engine

$E_t$  = efficiency of transmission system, engine to tires

$b$  = bore in inches

$s$  = stroke in inches

$n$  = number of cylinders

Either of these can be of help in determining engine size and in producing a well-balanced design. They are also of use in making general comparisons of ability characteristics.\*

In general trucks of today are correct as to type and contain reliable units. Some are firmly established as at least the equal of foreign competitors, but the cessation of hostilities has left us with valuable experience and new opportunities. Our chassis design is capable of development and we shall refine many details. From now on I believe we are going to think of "service" not as something rendered from a garage to keep our trucks on the road, but as embodied in our product, which must be designed and redesigned, studied and perfected to every reasonable extent within our means before being sent out of the shops with our trademarks.

Good detail will do it. Detail that serves reliability, accessibility, simplicity, weight reduction, speed, economy of operation and cost.

The head of one of our important trade publication companies, returning recently from a trip through the automobile factories of England and France, was much impressed with the air of solidarity and permanency of these plants. He was also impressed with the refinement of design and the finish of the products. He set forth his views on these things in a call to American manufacturers to perfect the details of their product and set up standards of high quality. "Reconstruction is at hand," he states. "The world is entering on new conditions. American manufacturing enterprise must now evolve from transient and short-lived dividend production to an institutional, permanent and constructive establishment which will outlive its progenitors and establish the solidity of American industry in the future markets of the world."

That is not a criticism, but a call that I believe is already being heeded.

\*See papers by the author on this formula in vols. 8, 9 and 10 of the *S. A. E. Transactions*.



## AMENDMENTS TO BY-LAWS AND RULES

**A**T the meeting of the Council held at New York City, Jan. 23, eight amendments to the By-Laws and Rules of the Society were approved. The amended sections, which are now in force, read as follows:

**B1**—All candidates for admission to the Society shall make application on a form approved by the Council. In the case of individuals the application form shall provide space in which shall be written a statement giving a complete account of applicant's qualifications and engineering or other required experience, and an agreement that he will, if elected, conform to the Constitution, By-Laws and Rules of the Society. He shall, if possible, refer to at least five individual members with whom he is acquainted.

**B2**—Applications for admission to the Society from persons who are not resident in the United States or Canada, or who may be so situated as not to be personally known to five members of the Society, as required in the foregoing paragraph, may be elected by the Council, after sufficient evidence has been secured to show that in its opinion the applicant is eligible for admission to the respective grade.

**B16**—The Secretary shall present to the Council the name of any member in arrears for more than three months, and such member shall not receive the publications of the Society until such arrears are fully paid. A person dropped from the rolls for non-payment of dues, if desirous of again joining the Society, must first pay dues in arrears to the time of being dropped and may then make a new application for membership as provided for in the Constitution and By-Laws of the Society in the case of new candidates for membership.

A member who resigns in good standing and desires again to join the Society, must make application for membership as provided under the Constitution and By-Laws of the Society in the case of new candidates for membership.

The Council may, however, in its discretion restore to membership any person whose membership has ceased for any cause, upon such terms and conditions as it may at the time deem best for the interests of the Society.

### MEETINGS COMMITTEE

**B19**—It shall be the duty of the Meetings Committee to procure professional papers, pass upon their suitability for presentation, and suggest topical subjects for discussion at the meetings. The Committee may refer any paper presented to the Society to a person or persons especially qualified by theoretical knowledge or

practical experience for suggestion or opinion as to the suitability of the paper for presentation.

The Committee shall arrange the program of each meeting of the Society, and have general charge of the entertainments to be provided for the members and guests at each meeting. It shall prohibit the distribution or the exhibition for other than reference purposes of all advertising circulars or trade literature at the headquarters or at the meeting place of the Society.

### HOUSE COMMITTEE

**B22**—It shall be the duty of the House Committee to have the care, management and maintenance of the rooms of the Society and its furnishings.

### CONSTITUTION COMMITTEE

It shall be the duty of the Constitution Committee to consider all proposed amendments of the Constitution and to make recommendations thereon.

### SECTIONS COMMITTEE

It shall be the duty of the Sections Committee to further the organization and work of the Sections and to make recommendations to the Council upon matters involving the Sections.

### CERTIFICATES

**B32**—Each member shall, subject to such rules as the Council may establish, be entitled to a certificate of membership, signed by the President and Secretary of the Society. Every such certificate shall remain the property of the Society and be returned to it on demand of the Council.

### TITLES

**B35**—The approved abbreviations of the titles of the various grades of membership are as follows:  
 For Honorary Members ..... Hon. M.S.A.E.  
 For Members ..... M.S.A.E.  
 For Associates ..... A.S.A.E.  
 For Foreign Members ..... F.M.S.A.E.  
 For Service Members ..... S.M.S.A.E.  
 For Juniors ..... Jun. S.A.E.  
 For Departmental Members ..... Depart'l Mem. S.A.E.  
 For Affiliate Members ..... Affil. Mem. S.A.E.

### PAPERS

**R4**—The Meetings Committee shall deliver to the Secretary all papers it recommends for presentation at the professional sessions of the Society meetings. Whenever possible this shall be done in time to permit the printing and distribution of the papers in advance of the meetings.

## CORRECTIONS FOR SERVICE DIRECTORY

**T**HE Service Directory of S. A. E. members which appeared in the December number of THE JOURNAL has been reprinted in pamphlet form and was distributed at the recent Annual Meeting of the Society. It is realized that while every effort was made to have this list as complete as possible before printing there are a number of members whose

names have been omitted. The booklet will be reprinted at an early date and it is urgently requested that all the members who have served the Government in any capacity whatever or are in service at the present time inform the New York Office of the Society. It is only by the cooperation of every member that the list can be made complete.

## PACIFIC COAST MEMBERSHIP COMMITTEE

**W**ITH an effort to increase the membership of the Society on the Pacific coast a local membership committee has been formed with George C. McMullen as chairman. All the members of the Society residing in that section are urged to cooperate with this committee, it being requested that each

member make a special effort to secure at least one new member. Frank B. Drake is the secretary of the committee, and all correspondence pertaining to the work of the committee should be addressed to him care of the Hess-Bright Ball Bearing Co., New Call Building, San Francisco, Cal.

# Automotive Ordnance Apparatus

By LIEUT.-COL. WILLIAM G. WALL, U. S. A.\* (Member)

ANNUAL MEETING PAPER

Illustrated with PHOTOGRAPHS

It is not believed necessary before members of this Society to go into the merits and advantages of motorizing the artillery, for to them the reasons will appear quite obvious.

A brief description will be given of the different vehicles developed and used; also the conclusions reached regarding their relative merits.

## NASH AND F.W.D. TRUCKS

It was early decided by a military board appointed for the purpose that the trucks used for artillery purposes should be of the four-wheel-drive type, and, as it was not considered advisable to wait to develop an ideal truck of this type, two makes of this type truck then on the market were adopted, one being the 3-ton F.W.D., and the other the 2-ton Nash Quad. On these two types of trucks were placed a number of the different bodies necessitated by the various uses to which they were put.

The engine used in the 3-ton chassis was a four-cylinder, 4 $\frac{3}{4}$ -in. bore by 5 $\frac{1}{2}$ -in. stroke; the 2-ton having a four-cylinder L-head type engine, 4 $\frac{1}{4}$ -in. bore by 5 $\frac{1}{2}$ -in. stroke. An Eisemann magneto was used on each of these trucks. The wheelbase of chassis in both cases was 124 in., and steel wheels with tires 36 by 6 in. were used. The gear reduction on low speed for the 3-ton was 36 to 1, and on the 2-ton, 42.3 to 1.

## AMMUNITION BODY

A steel body was used for this purpose, which was designed to carry packing cases for seven different sizes of ammunition and equipped with chain hoist to load the heavier calibers of this ammunition. The steel used in this body was No. 10 gage. Removable seats were also provided for carrying the personnel. A complete set of tools was attached to sides of body.

## ARTILLERY REPAIR TRUCK

The artillery repair trucks used the type of chassis mentioned above and consisted of a small machine shop with machine tools driven by electric motors, the power being secured from a stationary four-cylinder engine, 2 $\frac{5}{8}$  in. by 4 in., and a 4-kw., 110-volt multipole generator with complete switchboard.

The tools in this machine shop consisted of the following:

- 9-in. lathe, with milling and gear cutting attachment
- Vertical drilling machine for drills up to  $\frac{5}{8}$  in. in diameter, driven by a  $\frac{1}{2}$ -hp. motor
- Bench grinding machine, with two emery wheels, electrically driven
- Air compressor set with motor complete
- Oxy-acetylene welding and cutting outfit
- Two machinists' vises and one pipe vise
- Portable drilling machine
- Acetylene cylinder, besides a large assortment of small tools and necessary work benches.

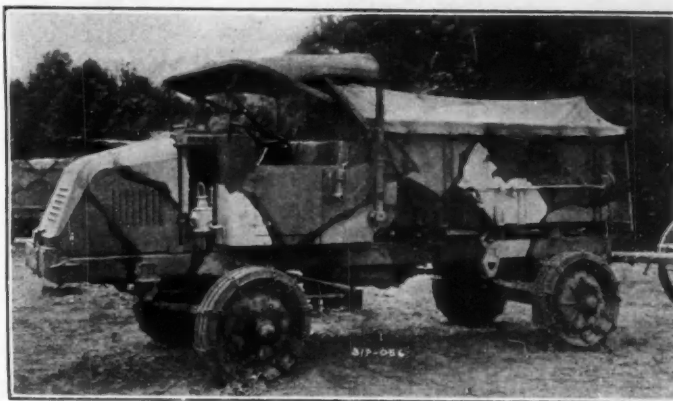
Nearly a thousand of these artillery repair shops were completed; also a number of heavy mobile repair shops mounted on trailers were made.

\*Motor equipment section, engineering division, Ordnance Department, Washington.

## ARTILLERY SUPPLY TRUCK

This type chassis was also used for the artillery supply trucks. This truck consisted of an open body with a number of chests containing the proper tools, which included: Carpenters' tools, saddlers' kit, chain block, grindstones, spare parts for optical instruments and optical repair equipment; cleaning materials; forge outfit in addition to chest for springs and fluids used for gun recuperators.

The artillery supply truck was an auxiliary to the artillery repair truck and the contents of the chassis were determined by the organization in which this truck was used, for example, the size, type of gun, etc. These trucks



STANDARD ORDNANCE 3-TON TRUCK WITH AMMUNITION BODY

also carried spare wheels and all the necessary spare parts for the guns and caissons.

## EQUIPMENT REPAIR TRUCK

The equipment repair truck consisted of the four-wheel-drive chassis with body, carrying the necessary equipment and machines for the repair of all equipment. The cabinets were made of sheet steel, containing all necessary small tools and spare parts required. Among the tools was a heavy Singer sewing machine and a Champion stitching machine, besides several vises. In fact, this truck carried complete equipment for the repair of all leather and canvas goods and small arms. All machines on this truck were pedal driven.

The light repair truck was for emergency repair work, and consisted of a special steel body on Dodge chassis.

## 3-TON TRUCK AND ARTILLERY WHEELED TRACTOR

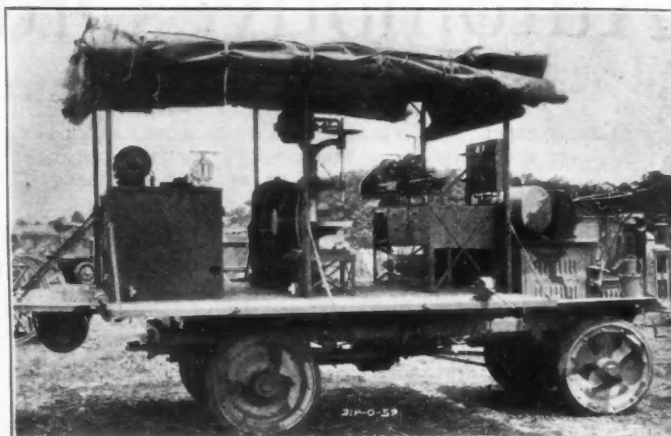
As soon as the procurement and production of two makes of four-wheel-drive trucks was well under way, so as to take care of all immediate needs, the design of a four-wheel-drive ordnance truck was started under the direction of one of your former presidents and later on certain changes were made in the truck for the purpose of converting it into a wheeled tractor.

A four-cylinder 4 $\frac{3}{4}$ -in. bore by 5 $\frac{1}{2}$ -in. stroke Wisconsin engine was used, as it was in production and nearer the right size and weight than any other.

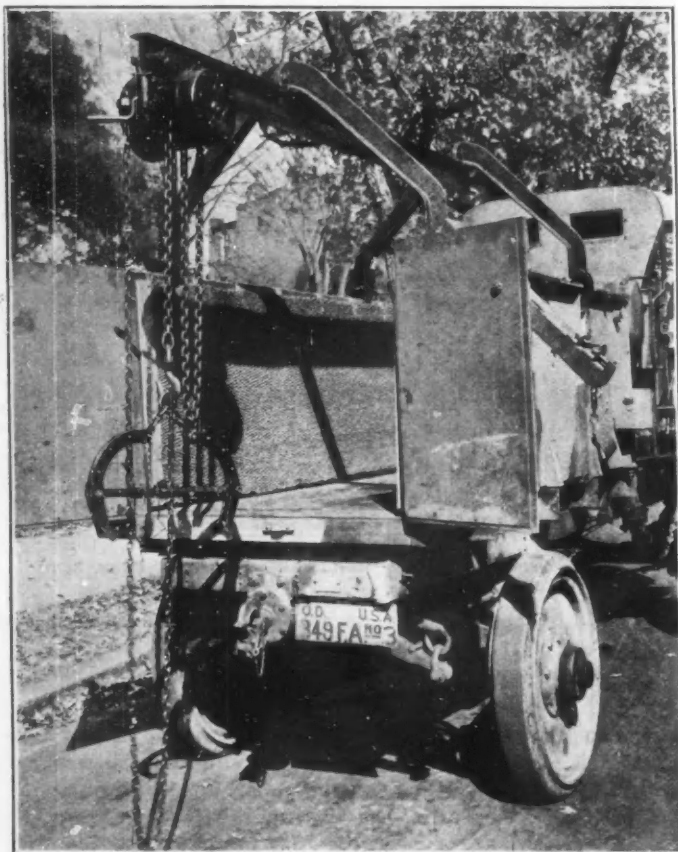
The Model B truck transmission, with four speeds forward and reverse and M. & S. locking differentials were used, the axles themselves being of new design with internal gear drive, the truck using 36-in. by 7-in. tires and the tractor 40-in. by 8-in. tires. An Eisemann magneto with impulse starter was used for ignition. The total weight of the truck was 10,500 lb., with a normal carrying capacity of 3 tons.

As a truck this vehicle had two-wheel-steer, but as a tractor in order to have short turning radius a four-wheel-steer was used, giving it a turning circle of 35-ft. diameter. As a truck the gear reduction was 68 to 1 on low and as a tractor 86.7 to 1 on low.

This vehicle is made so that any of the bodies previously described can be put on. When used as a tractor a winch was mounted at the rear end and a short body



ARTILLERY REPAIR TRUCK



AMMUNITION HOIST AND HEMP LINING FOR BODY

was provided for carrying sufficient load to give traction; also all necessary tools, etc. The winch provided on this tractor was designed so as to be capable of breaking 1½-in. Manila rope, equivalent to a load of about 18,000 lb. The drawbar pull of this tractor, as well as others, is given in the table attached.

#### RECONNAISSANCE, MACHINE GUN AND STAFF OBSERVATION CARS

It was found necessary to adapt a chassis for the use of the reconnaissance, machine gun and staff observation cars. The White Tebo chassis and the Commerce 1-ton chassis were used for this work. The former was used for the staff observation and reconnaissance cars and the latter for the machine gun car.

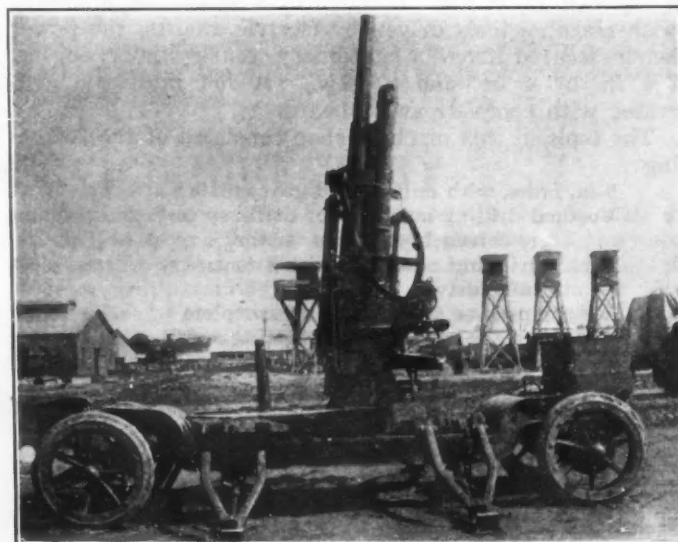
The White chassis used was the regular 1-ton, with

exception of a larger engine. This was of the four-cylinder type, 4¼ in. by 6¾ in. The chassis had 140-in. wheelbase, with four speeds forward and reverse, geared up on high speed.

For the staff observation car a regular seven-passenger chassis might have been used, but on account of the rough service to which it was subjected and the necessity of carrying certain observation instruments, it was deemed expedient that a special body be designed for this purpose. This body comfortably seats eight passengers and contains a number of lockers in which the compass, telescopes, protractors, plotting boards, aiming circle, flashlights, etc., are carried in addition to a number of other instruments necessary for artillery observation.

#### TRACK-LAYING TRACTORS

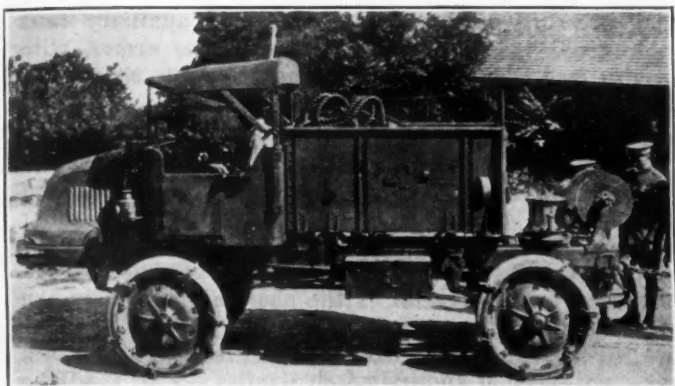
The conclusion was reached in the early months of the war that it was necessary to have tractors to haul some of the heavy guns over most any type terrain. A number of different types were tested for this purpose and decision reached that the track-laying type was best suited to the work. As the British had been using a few of the Holt caterpillars some of these were secured, namely: the 75 hp. or 15 ton and the 120 hp. or 20 ton, and the Ordnance Department started work immediately



3-IN. ANTI-AIRCRAFT GUN ON TRAILER

## AUTOMOTIVE ORDNANCE APPARATUS

183



ARTILLERY WHEELED TRACTOR

upon improved types of these track-laying vehicles in order to produce something more suitable for the army's needs.

It was deemed necessary that the front wheel as used on most of the heavier caterpillars be dispensed with; also that the engine and vulnerable parts be covered with armor plate. On account of the complaints made by the French that the caterpillars tore up the roads, it was decided that smooth-track caterpillars should be used, and the grousers made attachable, the latter to be put on only when going over shell-torn areas and where they would not in any way damage the roads.

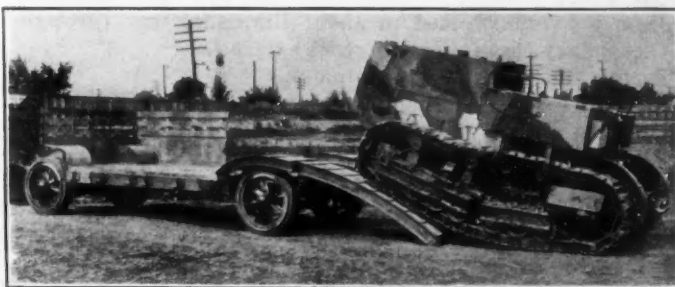
Several of these tractors were designed, namely; the 10-ton, 5-ton and 2½-ton tractors. The 10-ton tractor embodied most of the features of the Holt caterpillars, and, while it was a big improvement over anything which had preceded it, was very similar in a great many respects to other designs. The 5-ton departed very materially from any previous designs, and the 2½-ton was entirely different from any tractors previously built, although it possessed some of the Renault features.

The 10-ton artillery tractor has a four-cylinder, valve-in-the-head engine, 6½-in. bore by 7-in. stroke, cylinders cast separately; 55 hp. at 600 r.p.m., and uses a K. W. high-tension magneto with impulse starter. The transmission is of the sliding gear type, three speeds forward and one reverse, with direct drive on second speed. Both the main clutch and the steering clutches are of the dry-

plate multiple-disk type. The main frame is a steel casting, and the roller frames are built up of channel steel. These rollers are used on each side, and all are fitted with Hyatt roller bearings. Weight, about 21,000 lb., with pressure of 7½ lb. per sq. in., the width of the track shoe being 15 in.; tread of track center to center 61 in. The maximum speed of this tractor is close to 6 miles per hr. The capacity of the gasoline tank is 46 gal.; the drawbar pull on direct drive about 5000 lb., and on low gear 8000 lb. A cast-steel shoe is used with smooth tread arranged to receive grousers which are bolted on. Armor is used to protect the engine and the fuel tank, and, as on all artillery vehicles, a latch pintle is provided. This tractor is principally used to pull the 155-mm. gun.

The 5-ton artillery tractor was designed primarily to pull the 9.2-in. howitzer, which is divided into three loads, thus requiring three of these tractors to pull one gun. It was later used to draw the 6-in. howitzer in one load.

The engine is four-cylinder, valve-in-the-head type,

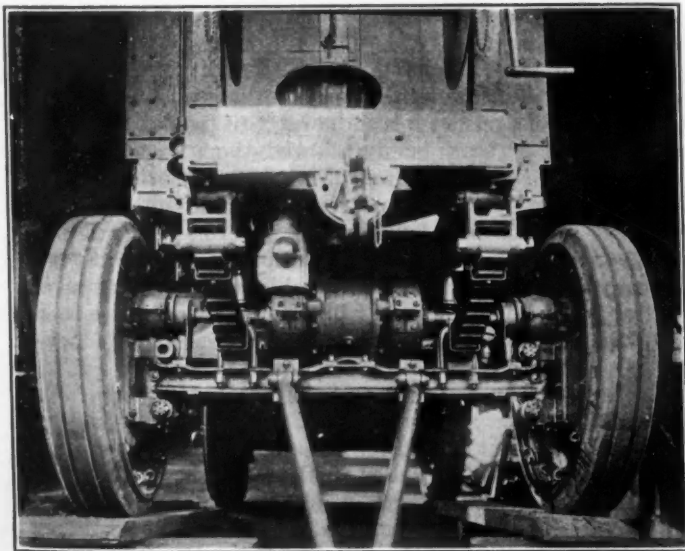


10-TON ARTILLERY TRACTOR MOUNTING 10-TON TRAILER

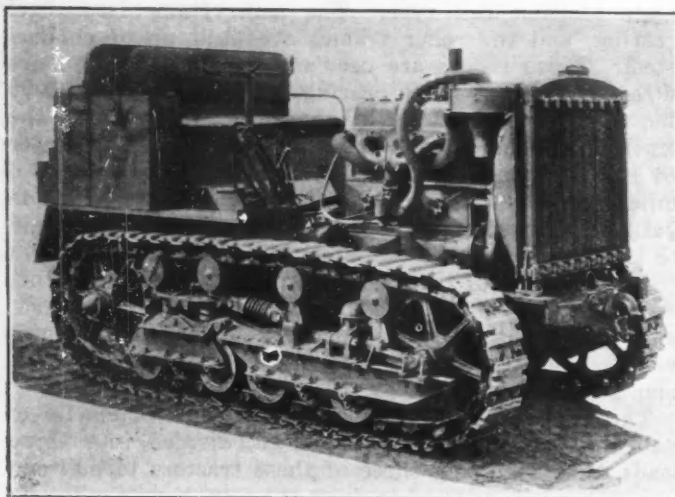
4¾-in. bore by 6-in. stroke, cylinders cast in pairs, developing about 56 hp. at 1200 r.p.m.; Eisemann magneto, with impulse starter, is used, and a Schebler carbureter provided. Both the main and steering clutches are dry-plate, multiple-disk type. The frame is cast steel and the roller frames are built up of channel steel. Track shoes are cast steel, 11 in. wide. The transmission has three speeds forward and one reverse, direct drive on second. The gasoline tank has two compartments, each holding 12 gal. The Bendix type hand-starter is used. Quite an interesting lubricating system is used in the engine. It is of a type which prevents excess oil at the rear cylinders when ascending a hill. A dry crankcase is maintained, as all oil which flows off from the crankcase is pumped out of the oil pan and delivered to the oil reservoir, from which it flows again under pressure through the engine bearings. A triplex geared oil-pump is used to accomplish this. Quite an ingenious spring radius rod is used on the track frames which very materially aids in the proper operation. The pressure on the ground is about 5 lb. per sq. in.

It was originally intended that the telephone and fire control cable be carried on a truck, but after extensive experiments it was decided to use the regular six-horse reel and to make a small 2½-ton track-laying tractor to draw it. Approximately two months before the armistice was signed it was decided to motorize the 75-mm. guns and these tractors were designated to pull them.

An eight-cylinder L-head V-type engine was used with 3⅛-in. bore and 5⅛-in. stroke, with about 70 hp. at 2600 r.p.m. This will be recognized as the Cadillac engine. A three-speed selective transmission with direct drive on

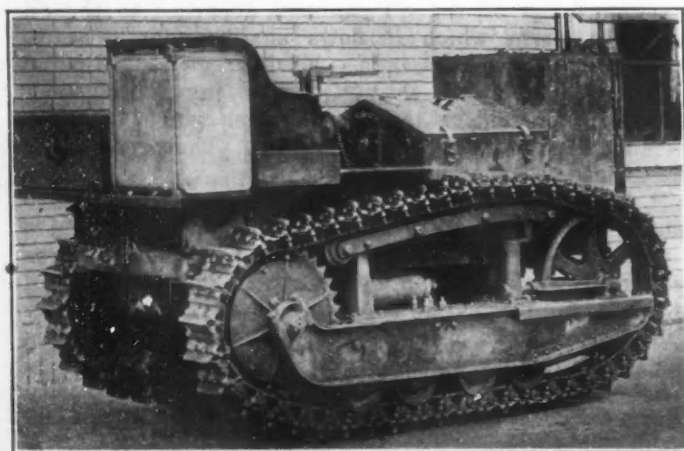


REAR AXLE OF THE ARTILLERY WHEELED TRACTOR



2 1/2-TON ARTILLERY TRACTOR WITHOUT ARMOR OR TOP

high speed was used and through this transmission, power was transmitted in about the usual way through a secondary transmission with steering clutches of the multiple-disk type to the track sprockets. The main frame of this tractor was built up of angle iron. The roller frames are the Renault type with four rollers on each side. Track shoes are of cast steel with bolted-on grousers. Armor is placed over the engine and tank. A regular ordnance pintle is supplied at the rear end. While the normal high speed of this tractor is 12 miles per hr., it will run 20 miles per hr. pulling a 75-mm. gun over level going. This tractor has a draw-bar pull of approximately 4000 lb. on low gear. The steering control on this tractor is a little different from the others in that the hand steering lever not only throws out the steering clutches but also puts on the brakes, making a very simple method of steering. The capacity of the gasoline tank is 20 gal.,



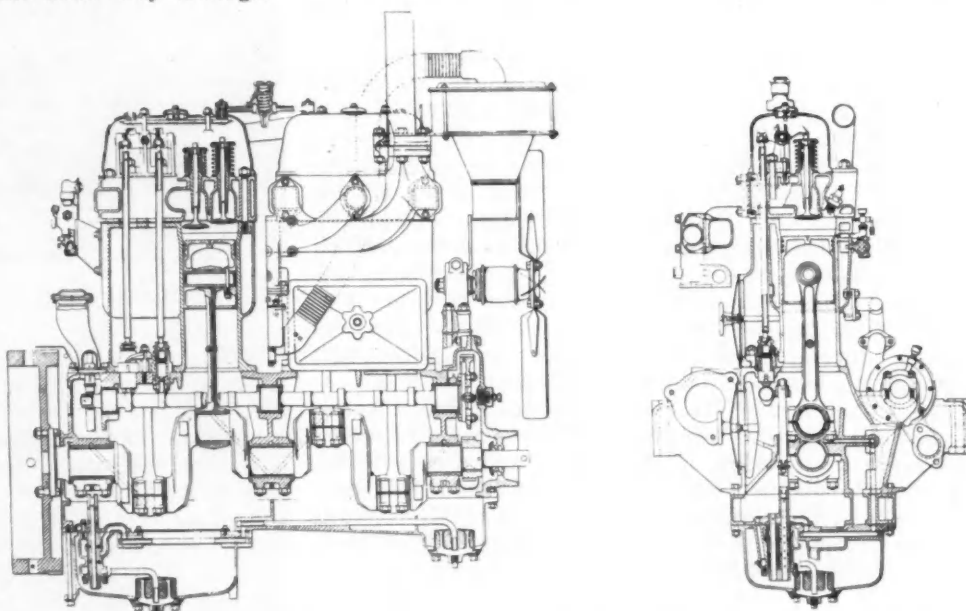
2 1/2-TON ARTILLERY TRACTOR

with pressure feed. There is also an auxiliary tank holding 5 3/4 gal., located under the engine armor, with gravity feed. The pressure on the ground is about 5 lb. per sq. in.

#### MARK VII TRACTOR CAISSON

One of the latest and most interesting designs is that of the Mark VII tractor caisson. This is a caterpillar cargo-carrier and while rated at a carrying load of 3 tons can carry 5 tons up a 45 per cent grade. The engine used in this tractor is the same as is used in the 5-ton artillery tractor, four-cylinder, 4 3/4-in. bore by 6-in. stroke. The total gear reduction is 100 to 1 with a maximum speed of approximately 6 miles per hr. It will be noted that the roller frame on this vehicle has nine rollers and is divided into two parts with a spring radius rod very similar to the 5-ton tractor. This vehicle has six speeds forward and two reverse. The pressure on the ground is about 7 lb. per sq. in.

One of the most interesting developments of the war was the placing of both light and heavy field guns on track-laying mounts. The 8-in. howitzer was placed on a

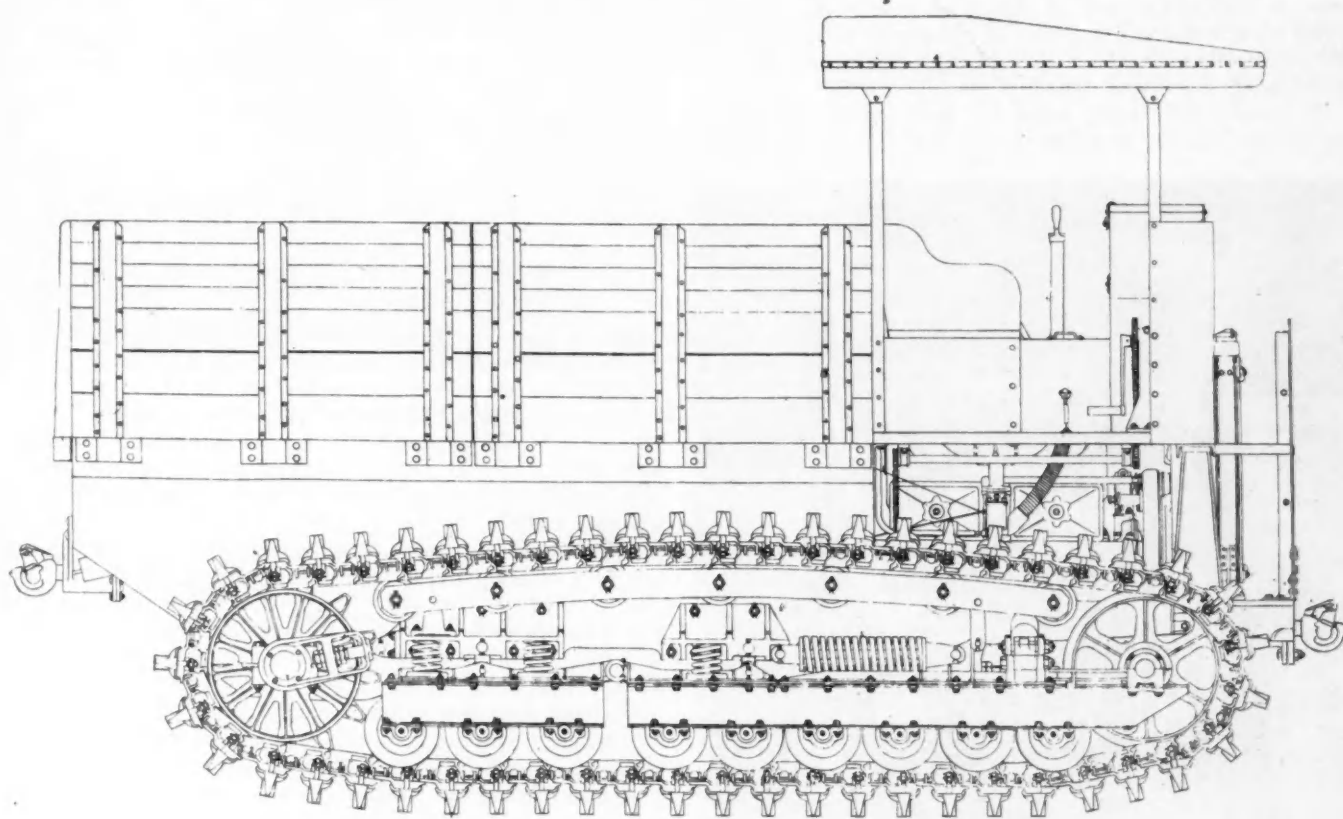


FRONT AND END ELEVATIONS OF THE ENGINE USED IN THE 5-TON ARTILLERY TRACTOR

track-laying vehicle giving a total weight of 55,000 lb. and capable of a maximum speed of about 4 miles per hr. From the artillery standpoint this was a very advanced piece of work as it allowed the gun to be run over any kind of terrain and brought into action within a couple of minutes after arriving. A mount was also made for the 75-mm. field gun by placing it on one of the 2 1/2-ton tractors, which was modified to suit the requirements. This gun was capable of traveling over most any rough ground and attained a speed on the level of 16 miles per hr.

#### TRAILERS

Several different types of trailers were designed, one of which was a 10-ton trailer for hauling the small tanks over good roads at comparatively high speeds; also a trailer for carrying 75-mm. field gun, and some smaller trailers in addition to the one used for the 3-in. anti-aircraft gun.



SIDE ELEVATION OF THE MARK VII TRACTOR CAISSON

#### TWO-WHEEL AND FOUR-WHEEL DRIVE VEHICLES

There has been considerable controversy, especially in military circles, in regard to the relative advantages of four-wheel-drive and the two-wheel-drive types of vehicles. There is no question in my mind that for good road hauling where deep holes are seldom ever run across and where the vehicle does not have to get off the road that the two-wheel-drive truck is a more efficient vehicle for cargo-carrying than the four-wheel-drive type, and is also preferable on account of the economy of operation and the lower cost of upkeep. There is a place, however, though it has very narrow limits, where the four-wheel-drive truck has considerable advantage over the two-wheel-drive, namely, on very bad roads.

#### WHEELED TRACTOR

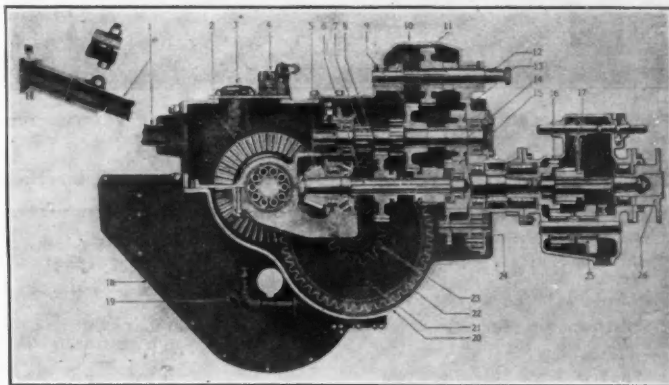
Used strictly as a tractor for work confined entirely to the roads, the four-wheel-drive rubber-tired vehicle has many advantages over any other type and it is believed there is nothing which can compare with it. It is not considered that the two-wheel-drive rubber-tired tractor has sufficient adhesion to the roads to make it a very important factor. The rubber-tired four-wheel-drive tractor has all necessary speed which is required, 15 miles per hr., and in that respect is much better than the steel-tired farm tractor of any type.

The friction coefficient of rubber tires giving proper adhesion to the road surface, with the proper gear ratio, makes the drawbar pull of this vehicle, for good roads, nearly the equivalent of the track-laying tractors and preferable to the steel-tired tractors. Economy of operation is greater than with either the track-laying or steel-tired vehicles. The cost of upkeep, considering speeds obtainable, is much less than either of the other types. This vehicle has its limitations, however, for while it

can be used on rather poor ground it is not believed that it compares in this respect with the track-laying tractor.

#### TRACK-LAYING VEHICLES

The track-laying or caterpillar tractor is the only one which can be seriously considered in going through deep sand and over very soft or rough and cut up ground, and it has been fully demonstrated that no other type of vehicle can compare with it in this respect. Its use, how-



SIDE VIEW OF TRANSMISSION USED IN THE MARK VII TRACTOR CAISSON

- |                                  |                                   |
|----------------------------------|-----------------------------------|
| 1. Oil filler tube.              | 14. High and second sliding gear. |
| 2. Bevel ring gear.              | 15. Main drive pinion.            |
| 3. Breather.                     | 16. Main drive coupling gear.     |
| 4. Steering clutch control cams. | 17. Countershaft sliding gear.    |
| 5. Bevel pinion.                 | 18. Sprocket sleeve gear plate.   |
| 6. Main pinion shaft.            | 19. Oil level stand pipe.         |
| 7. Countershaft reverse gear.    | 20. Lower transmission case.      |
| 8. Low and reverse sliding gear. | 21. Oil feed tube to pump.        |
| 9. Countershaft, 2nd speed gear. | 22. Intermediate gear.            |
| 10. Winch transmission case.     | 23. Intermediate pinion.          |
| 11. Winch sliding gear.          | 24. Oil pump assembly.            |
| 12. Winch spline shaft.          | 25. Auxiliary countershaft.       |
| 13. Countershaft driven gear.    | 26. Coupling.                     |

ever, is limited to work of this kind, due to its comparatively slow speed and expense of upkeep as compared with the rubber-tired tractor; also its high initial cost as compared with steel-tired wheeled farm tractors.

The main difference, however, between the track-laying vehicle and the wheeled vehicle, when the latter tracks

of the track stretching to any extent, to have roller frames so that whenever foreign substances, such as large rocks or limbs of trees, were caught in the sprockets that the length of these frames would be shortened sufficiently so as to prevent breaking of the track. This was worked out very nicely on the 5-ton tractor by the use of a spring radius rod; also the roller frames for track used on the 2½-ton tractor were developed so that a vertical coil spring was used to allow for this compensation.

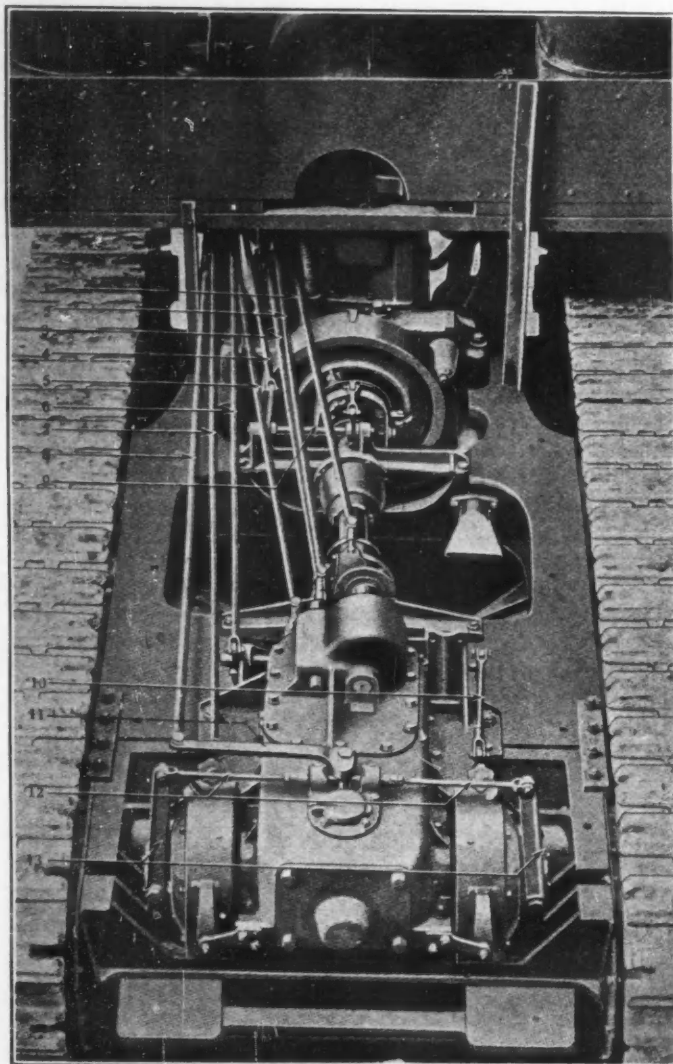
#### TWO OR FOUR WHEEL STEER

Experience has rather definitely proved that a vehicle with four-wheel-steer cannot easily be kept on the road at high speeds and 15 miles per hr. is about the limit. For this reason all cargo-carrying trucks should be two-wheel-steer, although the four-wheel-steer has considerable advantage in rough going, in turning corners on account of rear wheels tracking with front wheels. The wheeled tractor, however, due to the fact that 15 miles per hr. is the maximum speed generally required, and 95 per cent of the time it is running very much slower, and due to the great necessity for short turning radius, allowing it to maneuver easily in a limited space, requires that it either be of extremely short wheel base, which is not always practical, or else have four-wheel-steer, that is, both front and rear wheels should steer. The new artillery wheeled tractor is of this type as are also the Renault and Latil tractors used by the French.

A two-wheel-steer trailer running on four wheels cannot readily be backed into any particular desired location. It is somewhat easier to do this if it has four-wheel-steer, though as this is rather complicated for a trailer, it has been found desirable in a number of cases to have the rear wheels locked in position but capable of being steered by hand by the use of a bar.

Due to military reasons it was necessary for the army to use a certain number of trailers, some of which have been described, and the use of these trailers in several instances worked out very well.

The results of tests show that on hard roads, level going, or with very slight grades, the trailer has a number of advantages over carrying the load on top of the tractor; also where the bulk of the cargo is very great in proportion to its weight, the trailer works out admirably. When it comes to very rough going, especially off the roads in soft ground, tests made show that the same load can be much more easily and efficiently carried on top of the tractor than by its being carried in a trailer with a tractor drawing it. There are a number of rea-



VIEW LOOKING UP AT THE TRANSMISSION USED IN MARK VII TRACTOR CAISSON

- |   |   |
|---|---|
| 1. Shifting rod for auxiliary transmission. | 6. Brake rod for right steering clutch. |
| 2. Shifting rod for winch transmission.     | 7. Brake rod for left steering clutch.  |
| 3. Shifting rod for low and reverse.        | 8. Steering control drag link.          |
| 4. Control rod for master clutch.           | 9. Master clutch cross shaft.           |
| 5. Shifting rod for direct and high.        | 10. Clutch brake rod.                   |
|   | 11. Bell crank for steering clutches.   |
|   | 12. Steering clutch push rods.          |
|   | 13. Steering clutch shifter fork.       |

perfectly, like the four-wheel-steer, is due to the pressure per square inch exerted on the ground, it generally being very much less for the former and in practice somewhere between 4 and 9 lb. per sq. in. Also, the track is well anchored by the grousers and the sprocket, of those using sprockets, driving on the track prevents all slipping.

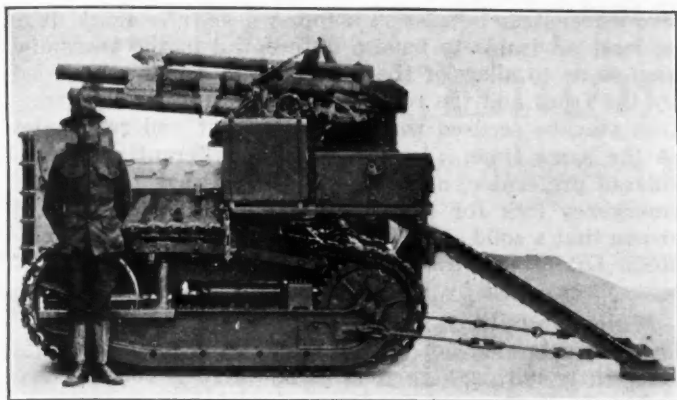
A track-laying vehicle necessarily weighs more than the wheeled type. This is due to the number of rollers running on the track and the weight of the track itself. At the beginning of the war very little attention had been devoted to the fact that to make a successful track-laying vehicle it was necessary, on account of the impossibility



8-IN. HOWITZER ON SELF-PROPELLED CATERPILLAR

## AUTOMOTIVE ORDNANCE APPARATUS

187



75-MM. GUN ON TRACK-LAYING MOUNT

sons why this is true, but evidently the main one is the fact that in one case it is only the pay load which is being moved and in the latter case it is the pay load plus a certain dead load equivalent to the weight of the trailer. This conclusion holds good even with track-laying trailers, for as a rule it is rather heavier in proportion to

## CATERPILLAR TRACK ADAPTERS FOR TRUCKS

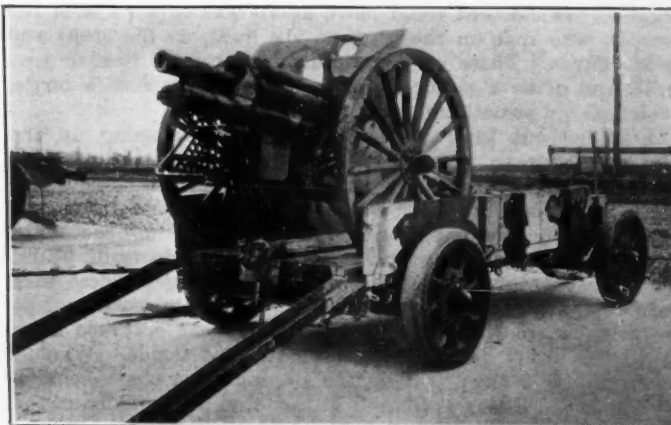
Quite a number of experiments have been made during the last two years in equipping the rear axles of trucks with caterpillar tracks or adapters. These generally consisted of a roller frame having from three to five rollers running on a track which in turn was either geared or driven by chain from the rear axle driving shafts. Experiments were tried on both the four-wheel-drive type and the two-wheel-drive trucks. The French had also been using an adapter, chain driven from rear axle on a number of Sauer trucks. Also, adapters of various sorts of the belt type running on the rubber tires of the truck wheels or with extra wheels added, have been tried. Experiments demonstrated, in the use of these various adapters, that a caterpillar track of this type attached to the rear axle of a truck driving on all four wheels was not at all practical as only a little over 50 per cent of the load was concentrated on the track, the remainder being on the steering wheels, which dug into the mud and rendered this type of vehicle of little more value in soft ground than the four-wheel type. On account of its limited speed it was not as serviceable for road work. Placing these adapters on two-wheel-drive trucks was a little more successful, but even under these condi-

NAME OF TRACTOR OR TRUCK	SIZE OF ENGINE	DRAWBAR PULL, LB.	WHAT IT HAULS AND NUMBER OF LOADS	HEAVIEST LOAD, LB.
Artillery tractor* 2½-ton, model 1918	Eight-cylinder, 3½-in. bore by 5½-in. stroke	4,000 low gear	75-mm. gun and caisson, 1 load Two 75-mm. caissons, 1 load Six-horse reel and cart, 1 load	4,500
Artillery tractor* 5-ton, model 1917	Four-cylinder, 4¾-in. bore by 6-in. stroke	5,000 low gear	155-mm. howitzer, 1 load 9.2-in. howitzer, 3 loads 240-mm. howitzer, 4 loads 4.7-in. gun, 1 load 10-ton trailer in tractor unit, 1 load 4-ton trailer, 1 load	16,230
Artillery tractor* 10-ton, model 1917	Four-cylinder, 6½-in. bore by 7-in. stroke	8,000 low gear 5,200 high gear	155-mm. G. P. F. gun, 1 load 10-ton trailer, 1 load 9.2-in. howitzer, 3 loads Substitute for 20-ton tractor	26,400
Artillery tractor* 15-ton, model 75-hp. Holt	Four-cylinder, 7½-in. bore by 8-in. stroke	10,250 low gear 8,900 high gear	5-in. seacoast gun, 1 load 6-in. seacoast gun, 1 load 8-in. howitzer, 1 load	32,148
Artillery tractor* 20-ton, model 120-hp. Holt	Six-cylinder, 7½-in. bore by 8-in. stroke	15,500 low gear 11,500 high gear	6-ton tank or 10-ton tractor on 10-ton trailer	24,215
Artillery wheeled tractor, model 1918	Four-cylinder, 4¾-in. bore by 5½-in. stroke	9,000 low gear	75-mm. gun and limber on field gun trailer, 1 load	9,500
Nash 2-ton truck used as tractor	Four-cylinder, 4¼-in. bore by 5½-in. stroke	4,000 low gear	75-mm. gun and limber on field gun trailer, 1 load	9,500
F.W.D. 3-ton truck used as tractor	Four-cylinder, 4¾-in. bore by 5½-in. stroke	4,000 low gear		

\*Track-laying type.

the load which it carries. The pressure per square inch exerted on the ground is, of course, a great factor in all hauling where the ground itself is soft or irregular, as in very soft ground the vehicle is continually climbing a grade or its equivalent.

The difficulty experienced in towing a long line of trailers behind a truck or tractor is very much simplified if they can be made to track, especially when rounding curves. It is apparent that this is possible only when four-wheel-steer is used on the trailers. The tracking of the front wheels of trailers can be controlled by the correctly proportioning of the length of the drawbar to the length from center of rear axle to pintle of truck and the relative length of drawbar front and rear of front axle when it is pivoted on the axle of trailer, the angle of steering arms controlling the relative angles of the inner and outer wheels.



75-MM. GUN ON FIELD GUN TRAILER

tions it was difficult to steer in deep mud, and the weight was considerably increased, in the case of the F. W. D. about 1500 lb. So that it was believed the placing of tracks on the rear wheels of trucks could only be considered a makeshift and the placing of caterpillar tracks on all four wheels of any vehicle makes steering extremely difficult and, in fact, if the vehicle carries any considerable weight, requires power steering.

#### INTERLOCKING DIFFERENTIALS

For cargo-carrying vehicles the use of interlocking differentials in rear axle or, in the case of four-wheel-drive, for both front and rear axles, has been of considerable advantage. The difficulty of securing a substantial interlocking differential, it is believed, has been the principal reason why most cargo-carrying vehicles have not been so equipped. Although one make on the market, which has been principally used, has held up fairly well. It is believed that this mechanism can be very greatly improved.

Considerable argument has arisen with reference to the advisability of the use of differential and whether it should be of the interlocking type, for the transmission, for four-wheel-drive trucks and tractors. In the case of a tractor steering all wheels, it is not absolutely necessary to have a differential as the rear wheels theoretically travel the same distance as the front wheels; but when

two-wheel-steer is used on a four-wheel-drive truck, it is at least advisable to have a differential in the transmission so as to allow of the difference in distance traveled by the front and the rear wheels and in order that traction may be secured through both front and rear axles at the same time. An interlocking differential is considered preferable, otherwise it is necessary to have an emergency lock for the differential. Experiments have shown that a solid shaft can be used even with two-wheel-steer, but excessive strains on the driving parts are at times occasioned by this design.

While for military purposes the front wheel on track laying tractors is not desirable on account of the difficulty in mounting a vertical bank, there is considerable to be said in favor of the front wheel for farm purposes on account of the greater ease in steering.

#### TROUBLES EXPERIENCED

In the work of the various vehicles used by the army, both at the front and in the service overseas, it is interesting to note that the troubles experienced have not been of a very serious nature, but rather with the small items, which have caused continual annoyance, and it is believed that on those small items, although seemingly rather insignificant, considerable engineering work can be done to great advantage.

## PARIS ON ARMISTICE DAY

I ARRIVED in Paris on the morning of Nov. 11. Nobody was sure that the armistice had been signed until about 11 a. m., when a number of cannon shots were fired. The effect of those booming guns was magic. Within an hour the streets were blocked with the surging, singing crowds. Never, never has such a sight been seen. Stores, banks and business houses of every kind closed immediately, and it seemed as if people flowed into the streets from every door. When there was room to move people danced in couples, in great zigzag processions, or in ring-round-the-rosies. Soldiers of every rank and nationality were acclaimed with shouts of joy, embracings and tears of gratitude. Americans especially were hailed.

I sometimes felt that as many processions of French soldiers, students and people of every kind and description were headed by American flags as by French flags. Everywhere there were the cries of "Vive l'Amérique"—everywhere, whether there were Americans in evidence or not. Every kind of vehicle that could move at all was covered with the people, who rode on the roof, on the hood, on the steps and mud-guards. Those on top usually had a great flag, or several, and often a poilu, a Tommy or a Yank, with a bugle, trombone or something noisy.

I sallied out into the crowd that was sweeping up the Champs Elysees and through the Arc de Triomphe, the chains around which had been burst asunder. Darkness had come to Paris, but every window was a blaze of light, and suddenly, one by one, the great arc lamps on the main squares and boulevards burst forth after a gloom of years. By some extraordinary luck we managed to get places in a cafe restaurant on the Rue Royal. Our seats were next to the window, so that we saw everything that occurred close by in the street as well as what happened inside. What a celebration! Women leading the singing from chairs, chains of Yanks and poilus marching in lock-step, filing in from the street and parading between the tables. After dinner the crowd engulfed us, carrying us this way and that in its

current. We jumped the steps of cars, already overloaded, and climbed the tops of auto trucks. At 3.30 a. m. I danced to a couple of fiddles and an oboe in the Place de l'Opera. At 4 o'clock I danced with the crowd at les Halles, the great market place where the country produce was being unloaded from the railroad cars by the light of great flares. The enthusiasm when I, an American, made my appearance on the outskirts of the dance was overpowering. The crowd surrounded me, yelling its delight. I shall never forget the faces of those that hemmed me in and the great number of arms that were stretched forward between and over shoulders to shake my hand. Almost all the women were draped in flags. Where they got them or how they got them, heaven knows. The effect was stunning in the dancing flare lights.

Shortly after 5 a. m. I was once more on the Boulevards, having finally escaped the crowd at the market where every poilu of every description pressed me to drink a health to *L'Amérique, La France et La Victoire*. The Boulevards by that time were fairly deserted except for those who, for lack of accommodations in hotels, slept or chatted or sang on the benches.

I counted at least ten captured German guns on the Boulevards. They had been dragged there from the Place de la Concorde. Near the Madeleine an 8.2-in. howitzer was progressing at a snail's pace, mostly in circles, propelled by the efforts of twenty very tipsy and talkative but thoroughly-earnest citizens and sailors. The only policeman that I recall having seen that entire day and night was one who hailed me to shake his hand down at the market place. Breakfast I had at a little place near Montmartre. Already the streets were filling up with a crowd similar to that of the day before.

I have laid so much stress on the buoyancy of spirit that perhaps I have not said enough about those who watched the rejoicings and tried to smile through tears. I saw the soul of France, I think, that day and night, and it was splendid.

—Ralph Bradley.

# Experimental Aeronautical Engineering

By ALEXANDER KLEMIN\* (Member)

ANNUAL MEETING PAPER

Illustrated with CHART AND PHOTOGRAPHS

**D**URING the war we have seen a tremendous development of the experimental side of aeronautical engineering. Broadly speaking, the construction of every new machine is an experiment even if no systematic tests of any sort are carried out, and the testing is that of usage as in the early days. In a more restricted sense, experimental aeronautical engineering is that technical branch of aeronautics which involves the systematic testing of an airplane or its component parts for the purpose of improvement or innovation, and this from the two main viewpoints of structural strength and performance, stability and controllability. This work, although it may be concerned with the very latest developments, is entirely distinct from the purely aerodynamic research of the physicist. It is engineer's work, and should be carried on by engineers, even though the physicist may have in some cases given the scientific foundation, or helped in devising accurate instruments. A very complete technique has grown up, and it is the principles and utilization of this technique that I shall briefly discuss.

## STRUCTURAL STRENGTH

However accurate and refined a stress analysis may be, the structure of a machine may be amply strong in its main members, such as spars, wires and struts, yet fail in the lug of a fitting or the crushing of a bolt embedded in wood, in which minor details computation may be entirely impossible and judgment alone has to be relied upon. In a machine of novel type, or even of one with a slightly varied truss, an error may creep into the stress analysis which will invalidate even the strength of the main members.

At an expense which is negligible when safety is considered, it is possible to eliminate much of the uncertainty of structural design by submitting the skeleton of a new machine to a sand test, in which air and dynamic forces in flight are simulated by the superposition of weights. This, and the usual strength testing of airplane parts, such as struts and wires, are the two main tools for investigating structural strength. In French practice sand testing seems to be restricted to the wing truss. In British and American practice sand testing has come to embrace the wings, the tail surfaces and controls, the fuselage and the engine mounting.

By far the most important sand test is, of course, that on the wings. We have acting on the wings two forces, lift and drift, which have to be simulated by the application of loads. A difficulty arises in the very enunciation of principles, because we do not know what condition in the air we wish to simulate. Complicated maneuvers such as a spin or a barrel are quite beyond us at the present moment in the analysis of the forces which come into play. We have, therefore, to consider simple maneuvers in one place.

A loop, a steep dive and a sharp recovery from a steep

dive are the three maneuvers which may be taken as imposing the severest stresses, and it is probable that in a loop skilfully executed the forces are inconsiderable. There remain the steep dive and the recovery from it. In the former the main forces acting on the wing are those of drag. The plane will, when it has attained its limiting speed, be at a very small angle of incidence, and between 50 and 75 per cent of the weight of the airplane

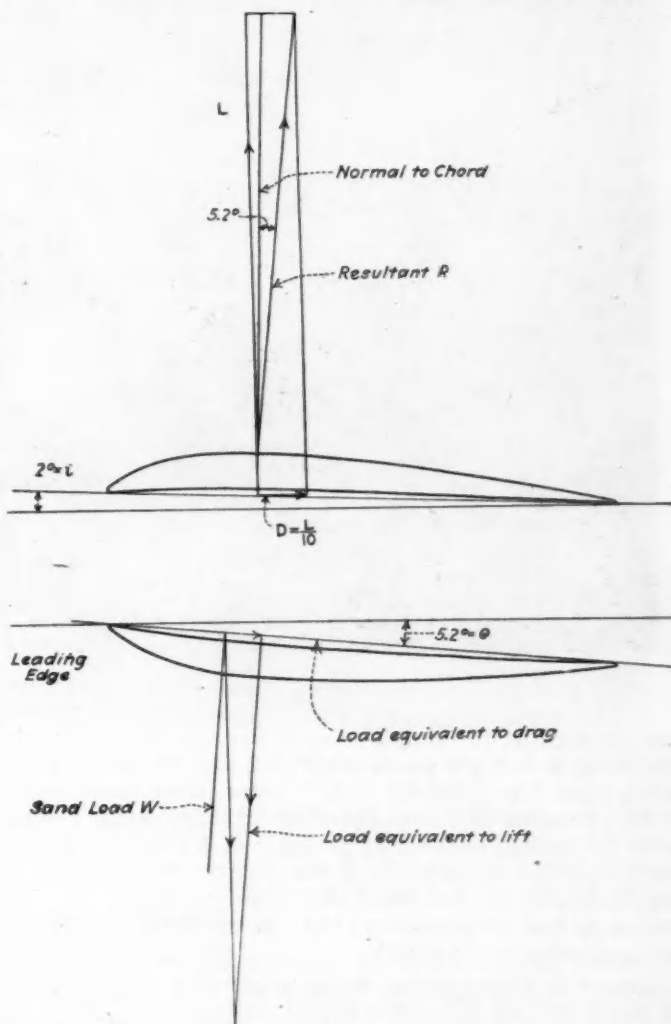


FIG. 1—DIAGRAM ILLUSTRATING HOW THE LIFT AND DRIFT COMPONENTS OF THE PATH OF AN AIRPLANE WING ARE REPLACED BY THE FORCE OF GRAVITY

will be supported by the drag forces on the plane. On recovery from a dive a totally different condition occurs. The machine is diving steeply, when the pilot pulls his elevator hard up and flattens out, describing a curve in space and imposing heavy centrifugal forces on the machine. In this case, before the machine has lost much of its diving speed it has been pulled up to a fairly large angle of incidence, bringing a very heavy lift load to

\*Consulting aeronautical engineer and technical editor, *Aviation and Aeronautical Engineering*, New York City.

bear on the wing truss, and the lift load on the wings is now much heavier than the drag load. No sand test can simulate both conditions, and hence a controversy is always possible as to the exact proportion of drag to lift which should be imposed in sand testing. As a compromise the tests of common practice are carried out under such conditions that the lift-drift ratio is as 4 to 1. This purely conventional loading at least simulates to some extent the conditions existing under a heavy dive, and at the same time we get a sufficiency of lift loading. Once adopted, and all machines being tested in the same way, we get at least comparative figures.

Fig. 1 illustrates how the lift and drift components

testing of a wing truss becomes a not too difficult engineering problem. In Fig. 2 is shown a typical set up of a plane before a sand test.

Sand is usually applied in small bags of 5, 10 or 25 lb. During loading the wings are relieved by the placing of jacks under the strut points, the jacks being slowly relieved when the loads have been placed, and deflection measurements are taken. Careful provision is made for limiting the possibility of a general collapse when failure occurs, as this would prevent the learning of valuable lessons that the inspection of a partially collapsed structure renders possible.

Beyond the mere numerical result of such and such a factor of safety, i.e., the wing truss being able to sup-

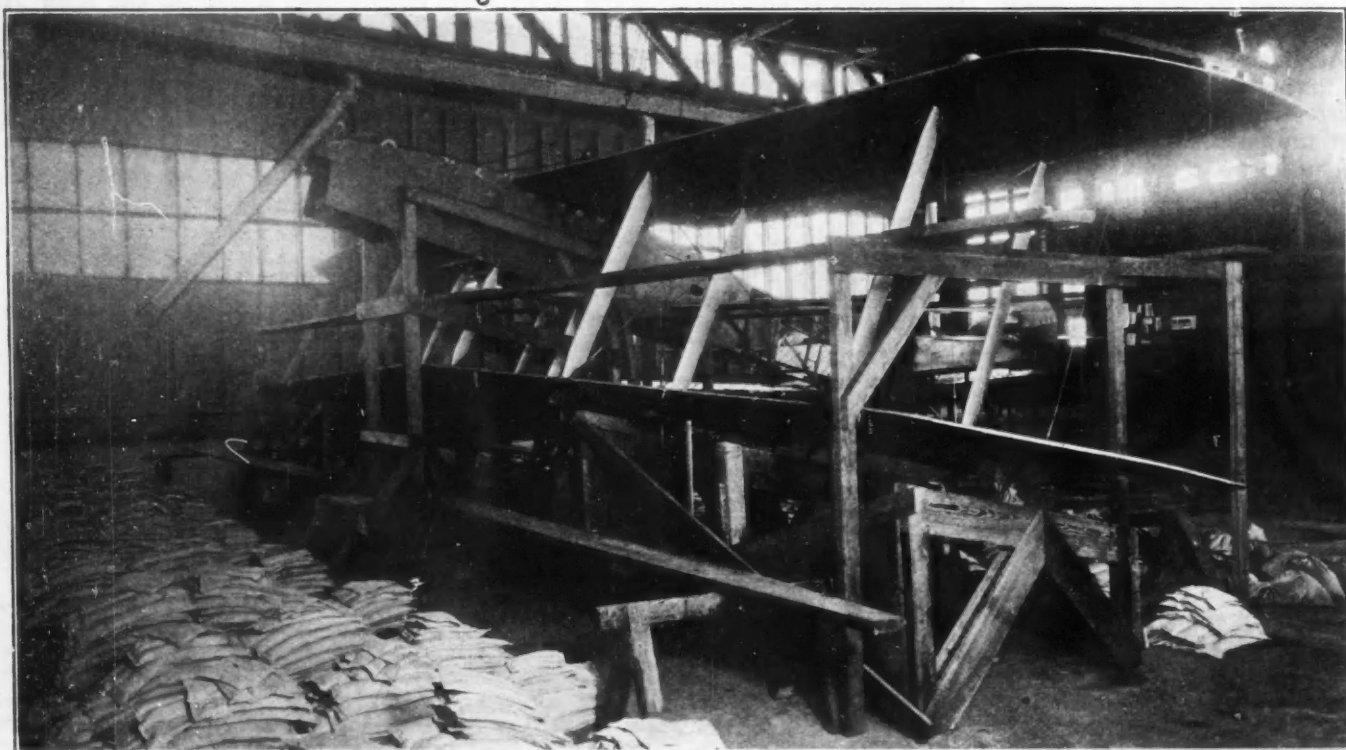


FIG. 2—A TYPICAL SET-UP OF AN AIRPLANE FOR A SAND TEST SHOWING THE ARRANGEMENT OF THE SCAFFOLDING AND SUPPORTS

are replaced by the simple force of gravity. Suppose that the wing is in flight at an angle of 2 deg. to the relative wind, and the lift-drift ratio under these conditions is 10. If under sand load the wing is placed upside down, with its leading edge up at an angle of 5.2 deg. with the horizontal, the components of the gravity force along and perpendicular to the chord will have the same relative values as the components of the lift and drift along and perpendicular to the chord.

Resolving forces along and perpendicular to the chord in full flight, we have, in a simple analysis,

$$D \cos i - L \sin i \text{ and } D \sin i + L \cos i$$

In sand load we have

$$W \sin \theta \text{ and } W \cos \theta,$$

$$\text{and writing } \frac{D \cos i - L \sin i}{D \sin i + L \cos i} = \frac{L/10 \cos 2^\circ - L \sin 2^\circ}{L/10 \sin 2^\circ + L \cos 2^\circ} =$$

$$\frac{0.9994/10 - 0.03490}{0.0394/10 + 0.9994} = 0.08925 \text{ while}$$

$$\frac{W \sin \theta}{W \cos \theta} = \tan \theta = \tan 5.2^\circ = 0.08925$$

With these simple principles established, and a number of aerodynamic refinements introduced, the sand

port so many times the normal load in flight, the designer or aeronautical constructor can learn a great many things from such an experiment. For one thing, it is a final check on inspection, as unduly early failure of a spar or a strut may disclose the fact that wood of poor grain or bad seasoning has been employed. The early failure of a shackle may lead to the discovery that an entire series of production shackles is valueless. In production work it is highly advisable to sand test a plane taken at random from say 100 specimens, this being the severest possible check on the inspection system at a plant.

#### SAND TESTING THE CONTROL SURFACES

In testing control surfaces such as stabilizer and elevator it is also possible to test the controls themselves, the joy stick, the connecting system of torque tubes, elevator arms, etc. It is a peculiar thing that a designer is less likely to be in error on the design of the structure of the wings than on the structure of the tail surfaces. The methods of stress analysis for the wings seem to be fairly well defined. For the tail surfaces fewer aerodynamic data are available; the structure is as a rule less

determinate and the members so small that there is a tendency for calculations to be neglected. Cases occur where a plane may be designed with particularly strong wings of heavy construction and yet the elevator must be attached to the elevator in the flimsiest manner.

In Fig. 3 is shown a typical set up of a test for the horizontal tail surface. Loads are applied and released in a fashion similar to that for the wings. For both the vertical and the horizontal tail surfaces a conventional loading is employed such that the mean loading per square foot of both the fixed and the movable surfaces is identical, but whereas for the fixed surfaces the loading is uniformly distributed, for the movable surfaces the loading is made to vary from zero at the trailing edge

In the strength testing of airplane parts we are on ground which is much more familiar to the engineer. The small common types of testing machine are all that is required as a rule. Special machinery is in process of development for the proof testing of struts to the elastic limit with subsequent use on the plane. Rib testing machines of various types are being developed. We may look confidently to the use of recording tension and stress meters in full flight for wires and cables. This branch of experimental aeronautical engineering while seemingly hackneyed and commonplace can, in the hands of skillful men, not specialists in testing but men with an appreciation of aeronautical problems, be made to give the most useful lessons.

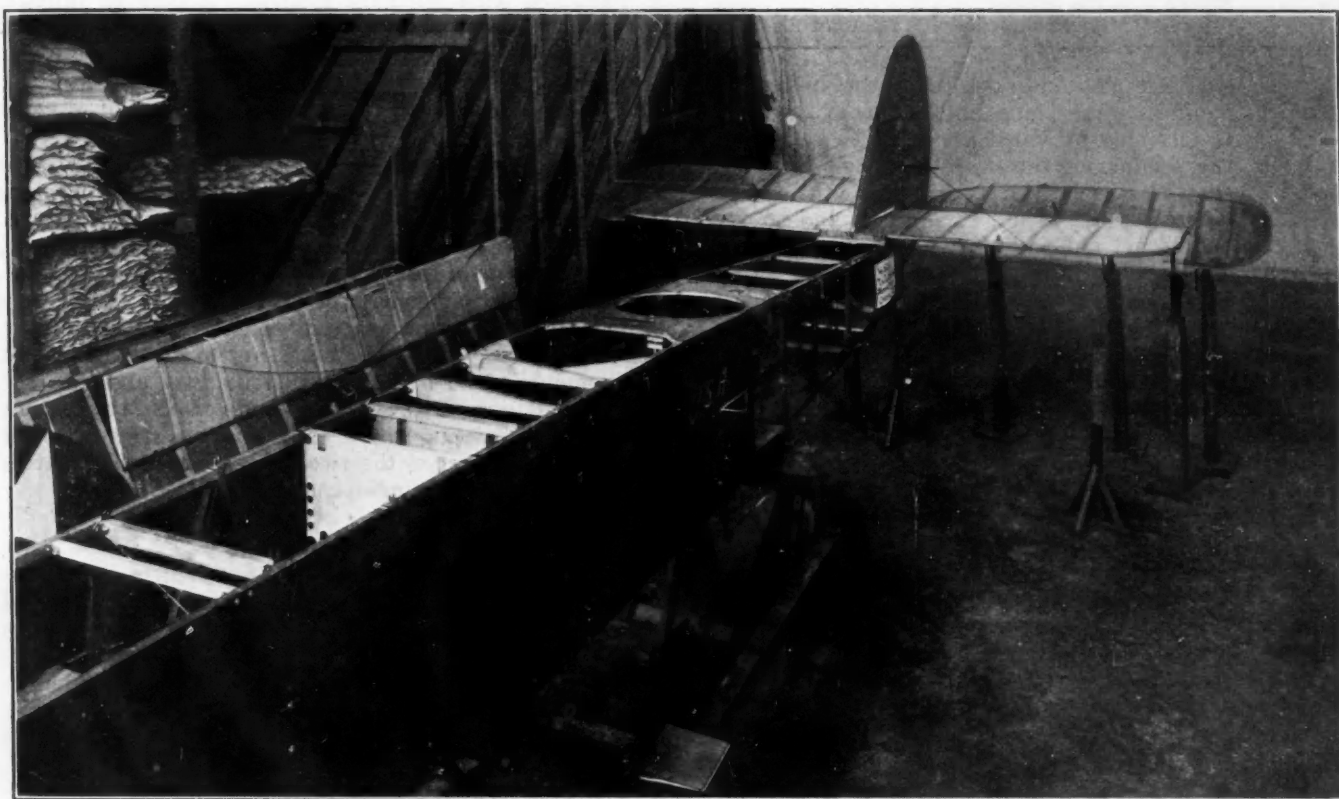


FIG. 3—A TYPICAL SET-UP OF A TEST FOR THE HORIZONTAL TAIL SURFACE

to a maximum at the leading edge. Such aerodynamic data as are available would seem to indicate that this method is rational. A study of numerous sand tests for the control surfaces indicates two or three specific points to be watched; viz, the attachment of elevator masts to the elevators, the necessity for having reinforcing wires from elevator masts to the trailing edge of the elevator in line with the control cable, etc.

The methods employed are too varied for discussion here. Tests reveal not so much weaknesses in the actual body structure as in the attachment of the lower wings to the fuselage, in the use of poor material in longerons, etc.

We are not concerned in a paper of this general character with the refinements of sand-testing methods. Sufficient has been said, however, to indicate that we have here a method which at least approximates conditions in the air. A plane which has successfully passed a sand test is not of necessity safe in the air, but it is quite certain that a machine which has not been successful on sand test is not safe in the air.

In the experimental study of performance, stability and controllability, there are two main avenues of approach; the wind tunnel and actual full flight tests. Both have their definite utility and both can be misjudged and misused.

#### PERFORMANCE PREDICTION BY WIND TUNNEL TESTS

The technique of wind tunnel experimentation has been so often dealt with that it would be supererogatory to go into details on its principles and methods. Briefly speaking, we have in the wind tunnel a tube in which is placed a small model of the actual airplane, past which air is drawn at a well regulated speed, while the forces on the model are measured on a suitable and carefully designed balance. Unfortunately wind tunnel literature has been written very often by investigators of the utmost experimental skill, but of a restricted point of view. In such cases the tendency has been to view the wind tunnel as a final court of appeal.

It has been rightly pointed out that in the tunnel conditions can be made to suit the case, that no risk is pres-

ent, that the expense and difficulty of small model experimentation is small, and that endless problems can be tackled. This is perfectly true. It is also true that great precision of measurement is possible in the tunnel, and that for the forces measured errors of not more than 1 per cent need be present. There are, however, certain very grave difficulties. The models can never be absolutely correct in view of the small scale. The scaling up of forces in accordance with the square of the linear dimensions and the square of the speed is not at all accurate. It can be demonstrated by the laws of dimensional theory that air forces on any body can be expressed by the equation

$$R = e v^2 l^2 f(vl)$$

where  $e$  is the density  
 $l$  a linear dimension of the model  
 $v$  the speed

Experimentation also indicates that the law of the square of the linear dimensions and the law of the square of the speed hold only provided the value of  $vl$  is a constant, i.e., the product of the linear dimensions and the speed. Even with the largest tunnel available and the highest speed compatible with a steady flow and no overheating in the tunnel, the full size values of  $vl$  cannot be even approached. And it has been demonstrated both in the tunnel and by full flight experimentation that with increased values of  $vl$  the lift coefficients increase and the drift coefficients diminish in value. It would seem at first sight as if the tunnel were useless for performance prediction. There is, however, an asymptotic effect to these variations, and by performing experiments in the wind tunnel at various values of  $vl$ , corrections can be obtained which will give fairly accurate transformation values from the model to the full scale machine. By conducting full scale experimentation in conjunction with wind tunnel work these correction values can be checked and with a little experience and some empiricism an almost exact prediction of performance can be obtained.

The practical man is right in criticizing the wind tunnel expert who places implicit faith in the prediction values given by the tunnel, but if the tunnel is rightly used and corrections based on experience skilfully applied, if engineering instinct is brought to bear on the subject, the tunnel can be used for prediction of performance. The value of this in experimental design need hardly be emphasized.

There is another aspect of the prediction of performance where the tunnel can give exact answers, namely, in the comparative study of machines. Even more important than to know what performance a machine will give, is to know whether one machine will be better than another. If accurate models of two machines are constructed, if they are tested with the same scale and under the same wind velocity conditions, the better machine can almost infallibly be selected.

Almost of the same order of importance in experimental design as the prediction of performance is the question of stability. Stability experimentation in the air is particularly unsatisfactory and even dangerous. A bad error in the stability of a machine may result in an accident on the first flight. The question arises how far the wind tunnel stability tests may be trusted. While the scale effect,  $f(vl)$  causes variation in lift and drift coefficients it has but a slight influence on the movement of the center of pressure. If the stability on a glide is considered therefore, the wind tunnel center of pressure or force vector diagram may be implicitly trusted. But

when the engine is running the slip stream of the propeller has a disturbing effect on the tail of the machine, and exactly what this disturbing effect is remains a matter for investigation. Here again the wind tunnel results must be skilfully used.

If stability tests in the air are coordinated with wind tunnel tests, if empirical corrections are made for a number of machines, the engineer will be able to pass on the longitudinal stability with sufficient accuracy. Particularly when trying out a new machine, with a new wing curve, or a tapered wing, or a swept back wing, a wind tunnel test is absolutely essential to give some idea of the variation from the normal. On the whole perfectly satisfactory results can be obtained if engineering empiricism is combined with scientific method. Either an implicit trust in the scientific method or a brutal disregard for it will sooner or later lead to dangerous results. For lateral stability, where slip stream effects of the propeller are negligible, the tunnel provides an almost exact criterion.

In controllability little has been done in the tunnel hitherto. Constructors have preferred to build machines with fixed and movable surfaces proportioned in accordance with the average values of previous successful types. The method is safe as long as we are dealing with average types. But if new types are evolved, exceedingly large or very small machines, then something more exact will be required. It will be necessary to make a study of the moments of inertia about various axes, and then for various settings of the tail surfaces, to determine the controlling moments which can be imposed, and to fix certain ratios between the two. In work of this character the tunnel will be indispensable.

#### FULL SCALE METHODS OF PERFORMANCE TESTING

For the testing of performance a complete and satisfactory technique has now been developed. With the aid of a few simple instruments such as a barograph, a recording thermometer, a recording speed indicator and a tachometer, complete engineering data can be obtained on maximum speeds, rates of climb, the revolutions of the engine, ceiling, speeds at various altitudes, etc. The sole requirement which constitutes a real difficulty is the calibration of the air speed indicator. No matter how carefully constructed or calibrated in the laboratory, the air speed indicator must be calibrated over a measured 2-mile course, and since this has to be done at an altitude of not more than 1000 ft., the field has to be very large or the surrounding country very clear of obstructions.

It may be stated that the testing for performance has now reached a point of sufficient accuracy. There may be further refinements, but from the practical engineer's standpoint the problem of full flight testing is on a perfectly satisfactory basis. The real snags now are not in the instruments or in the methods, but in the careful preparation of the plane and engine for test, and in the work of the pilot. Two pilots climbing the same machine may show a difference in altitude of over 1000 ft. in the first 10-min. climb, because one of them has not selected that speed on the climb which gives the best results. A faulty carbureter adjustment may spoil the record of a perfectly good plane; a variation in incidence of the main planes may spoil the climb.

In the tests for stability, reliance has hitherto been placed almost entirely on the judgment of the pilot, with the result that one pilot may report a ship tail heavy, and another nose heavy. The great problem here is to elimi-

## INVENTIONS SECTION OF THE ARMY

193

nate the personal equation. This can be done by very simple methods, such as placing spring balances on the joy stick to show the exact effort exercised by the pilot under varying conditions of flight, or by using gadgets to indicate the position of the elevator for various conditions of flight. If such methods come into general use not only will the personal equation be largely eliminated, but a great deal of exact data on stability collected which will facilitate further designs.

The difficulties in devising the scientific testing of lateral stability are exceedingly great. For the time being we have to place entire reliance on the pilot's report of how the airplane executes certain maneuvers, such as steep banks, side slips, etc. To a very great extent this is true for controllability also, and no criterion beyond the pilot's opinion seems possible at the moment.

The scope of general full flight testing beyond performance and stability and controllability testing is almost endless. The installation of a thrustmeter will give us the most valuable information on the propeller. The final answer as to whether radiators on the nose of the fuselage, a radiator in the wings or free radiators on the sides or underneath the fuselage are to be used can be supplied only by a systematic investigation on the same machine. The scope of such work is endless. Not only will it have a scientific value in the accumulation of

knowledge, but it will repay the practical constructor by the improvement of his machine.

## CONCLUSIONS

In this paper experimental aeronautical engineering has been touched upon in the briefest manner. At some future date I hope to set forth in detail the principles and practice of this important branch of aeronautics. It is hoped, however, that enough has been said to indicate the scope and possibilities of this work. If the experimental tools available are employed in a skilful, and above all, an engineering manner, airplane progress becomes a foregone conclusion. Employing our methods of structural investigation we can make the airplane strong enough and safe from this point of view. Our wind tunnel and full flight testing will bring speed, stability and controllability. It is my opinion that in the airplane, although there is an enormous scope for purely mechanical skill in design, the foundation for real progress is mainly based on patient investigation.

Heretofore work of this character in the United States has been done mainly by the army and navy air services. With the advent of peace the industry will certainly shoulder a portion of this work, and prompted by the drive of competition will surely achieve results of commercial value.

## INVENTIONS SECTION OF THE ARMY

**D**URING the war period more than 100,000 ideas, suggestions and inventions were received and passed upon by the Navy Department and the Naval Consulting Board, either separately or jointly. The Inventions Section of the General Staff, which was organized more recently, has handled over 25,000 such matters.

Inventions received are divided roughly into four classes:

- (1) Those which have no intrinsic or suggestive value
- (2) Those which, while having no real value in themselves, suggest new lines of thought and investigation
- (3) Inventions which have considerable promise, but are not developed to a point where it is possible to pass judgment on them
- (4) Inventions which are sufficiently perfected so that they can be investigated and tested

Ample facilities for testing inventions of the fourth class are provided by the Bureau of Standards and the Bureau of Mines in Washington.

In many instances inventors have neither the funds nor scientific knowledge and mechanical skill, to perfect their own inventions. Hence aid in each of these directions is necessary in order that the country may reap the full benefit of the originality of its citizens.

In no department was the danger of inadequate preparation for national defense felt so severely as in the scarcity of engineering officers and the ignorance of military affairs on the part of those that were obtainable. It is argued that it should be insisted upon that in every engineering school the students be given a thorough military training. This is upon the basis that it is to the engineers that the country must look for officers to supplement the efficient, highly trained,

but numerically inadequate supply graduated from West Point and Annapolis.

Lists of the officers and members of the various engineering societies have been filed with the War and Navy departments, and the Army and Navy officers have been requested to continue the work which was carried on by the War Committee of Technical Societies, through the secretaries of the different engineering societies directly.

In connection with the whole work in question, it is quite easy to say in an off-hand way that there is a problem in a certain line of activity of the Army, but it is quite another thing to determine that disclosure will not give information to the enemy, that it has not been solved elsewhere and that no one is working on it who would be embarrassed by the publicity.

In the formulation of statements of problems, after determining the state of a given art, the difficulty at hand should be so described as to direct the attention of the prospective inventor to the difficulties to be avoided, and the ideal to be obtained should be set forth to indicate what should be striven for.

The method the War Committee evolved for mobilizing the inventive talent of the country will doubtless be used by the Army in its war and peace plans. Governmental or private agencies should be formed to continue the work of advancing the arts and sciences by formulating the state of different arts, difficulties and ideals, and to secure competent trained men to work on problems. Such action would be of untold benefit to the country, in the opinion of Capt. Lloyd N. Scott, secretary of the War Committee of Technical Societies, which has been discontinued as such.

# Engineering Division of the Motor Transport Corps\*

THE performance of motor vehicles, of their parts and equipment and of their materials is of great interest to the engineer. To solve hundreds of design problems quickly and wisely, the engineers connected with the military motor transport program have had to gain wide and accurate knowledge of military vehicle performance. This article will discuss the sources from which the Engineering Division of the Motor Transport Corps has obtained performance intelligence; it will explain the methods of using such sources and give examples of typical data, although the space available is too limited to do justice to all these. Assistance of great value was given to the Division by patriotic individuals and companies connected with the American motor vehicle industry, by other departments of the Government, by the engineering societies of the country and by motor transport representatives of Allied governments.

The sources of performance intelligence used by the Division are indicated in part in the accompanying chart. The main source naturally has been the Motor Transport Corps of the American Expeditionary Force. In this country the sources can be considered as (a) experimental and (b) operation, although these cannot be sharply divided. In the early days of the war, for instance, the testing and experimental section of the Engineering Division concentrated mainly on devices in a production stage, but requiring development. Later on its work was to a greater extent along research lines. The Bureau of Standards also was engaged chiefly with experimental devices or materials. The organizations listed under operation sources, on the other hand, supplied information relating to vehicles and equipment supposedly in a more advanced state. The information was such as would be obtained in ordinary operation and not from any special road or laboratory tests.

Four main streams of performance intelligence are thus indicated on the chart. Motor Transport Corps designs and specifications were based primarily on data obtained from the American Expeditionary Force. Information regarding the special requirements of the different branches of the army was supplied by the Motor Vehicle Board, which approved the general type and construction of standardized vehicles. The sources listed under experimental and operation were also exceedingly important in supplying the data required to prepare designs.

## CONTACT WITH AMERICAN EXPEDITIONARY FORCE

During the war couriers, letters and cables were constantly being interchanged between the Motor Transport Corps abroad and in this country. All this was part of the effort to minimize as much as possible the difficulties caused by the great distance between the American Expeditionary Force and its industrial base in this country. The Motor Transport Corps intelligence received from overseas related to motor trucks, passenger cars, sup-

plies and repair parts, motorcycles, accessories and to general matters. The engineering information consisted mainly of outlines of what the vehicles would be called upon to do, of the actual results being obtained from vehicles already in use and of comments on the work that was being done or planned in the United States.

In many cases difficulties with vehicles developed both on this side and in the force abroad, and investigations were carried on simultaneously. Civilian advisory boards of engineers were sent from this country to the other side, where they studied the motor transport situation. As a result helpful suggestions were made to the forces in action in regard to the maintenance and operation of their vehicles, and the members of these boards also brought back considerable useful data to this country. Complete drawings and parts lists for the American Expeditionary Force vehicles were sent overseas, where they were used by the repair organizations. In many cases makeshift changes had to be made, one vehicle being robbed to keep a number of others in operation, or new parts manufactured from the local sources of supply. An overseas Engineering Branch was engaged in adapting vehicles to special uses, this being emergency work that could not have been foreseen in this country. An extensive scheme for reconstructing vehicles was planned, salvaged parts being used. The Engineering Branch also standardized the sizes of solid and pneumatic tires, and engaged in other work to eliminate the number of spare parts required for the motor vehicles in service. The engineering problem on the other side was complicated by the fact that a large number of foreign vehicles had been purchased at a time when there were no facilities available for shipping vehicles from the States.

## WORK OF INVENTIONS SECTION, GENERAL STAFF

Early in the year 1918 all branches of the army in the United States were ordered to submit patented or other devices of an experimental or untried nature to the Inventions Section of the General Staff. Hundreds of ideas, drawings and models were considered by the Section, and those of military value were submitted to the appropriate departments of the Army. The Engineering Division received regularly from the Inventions Section information regarding the motor transport devices submitted. Specific problems were submitted by the Division to the Inventions Section and the latter assisted materially in their solution.

It is understood that a large part of the ideas submitted, at least those relating to motor transport, were of little value, either because the manufacturing methods that must be followed in this country were not considered or conditions in the American Expeditionary Force were not understood. To overcome the latter difficulty statements outlining operating conditions were prepared by the Inventions Section and made public through engineering societies and other channels.

## ACTIVITIES OF THE BUREAU OF STANDARDS

The Bureau of Standards during the war undertook an immense amount of work for all the different branches of the Government. Its elaborate equipment and expert personnel were used by the Engineering Division in ob-

\*Activities of the Engineering Division of the Motor Transport Corps were described in the January and February issues of THE JOURNAL. The first article related to the general activities and the second described the design work of the Division. The source of the articles is the Engineering Division of the Motor Transport Corps.

taining information as to the properties of materials and the performance of certain special devices. Steels, alloys, leathers, textiles and other materials were tested and investigations made of anti-freeze compounds, spark-plugs, steering and road wheels, fire extinguishers, lock-nuts and similar equipment.

An example of the work done by the Bureau is the tests made of solid and pneumatic tires. Although the real test of tire performance is the road mileage, it is possible after tests of tires giving satisfaction in military service have been made to use the results in predicting the performance of other tires. In preparing the tire specifications samples of both pneumatic and solid tires were purchased in the open market and subjected to elaborate physical and chemical tests. In the pneumatic tires the tensile strength of the fabric and of the rubber was measured; many tests for the adhesion between the fabric and different parts of the rubber were made. The proportions of acetone extract, sulphur and carbon products were determined. The data thus obtained were used in formulating specifications, and tests were continued later to check new products submitted for approval. A somewhat similar course of action was followed with solid tires.

#### ROAD TESTING OF TRUCKS

A large room in the east basement of the Union Station, Washington, rented Aug. 3, 1917, was the first laboratory of the Testing and Experimental Section. Here the samples of Class B, A and AA engines were tested, and headquarters were established for the road testing of the sample Class B truck, which was started October, 1917. In testing these samples short runs only were made during the first few weeks; afterward longer trips were made over the Blue Ridge Mountains in Virginia, where there are some of the worst roads in the State. In the early testing the trucks were driven in the smallest possible circle each day for a short time, in both right and left hand directions, to test the locking differentials installed on the sample machines.

Early in 1918 the road testing was put on practically a 24-hr. basis. The performance of the new Class B trucks was compared with that obtained from commercial trucks of similar capacity. While the test of the sample B trucks was continued, production types were obtained as soon as possible and put on the road. One of the latter was driven about 18,000 miles by the Section, and eight Class B trucks were given road tests of over 10,000 miles. This intensive work quickly developed any faults. Troubles in the clutch, universal-joints, worm thrust-bearings, brakes and steering mechanism were experienced in the testing and steps taken immediately to correct the design. Soon after receiving the sample trucks it was decided to increase the rear wheel diameter from 36 to 40 in. At a later date the load rating of the B truck was increased from 3 to 5 tons, the springs and other parts being strengthened to care for the increased load. While the Class B truck was approved for a standard heavy-duty cargo carrier by the Motor Vehicle Board, tests of the production type trucks were continued to check the performance of parts that had been redesigned and also to detect any other weaknesses that might develop.

The three Class A sample trucks were received early in January, after being driven overland from the factories where they were assembled. These were immediately put on 24-hr. tests. After running about 3000

miles trouble developed in the internal-gear rear axle. The load-carrying tubes broke at the point where they joined the axle housing. Tests also showed that other changes should be made in the transmission and gear-shift mechanisms. Two of the sample Class A trucks were run about 14,000 miles, but the work was discontinued after another type of vehicle was standardized for 1½ to 2 ton service in the army.

Four Class AA vehicles arrived in Washington in February, 1918 and were immediately placed on road test. After about 3000 or 4000 miles considerable trouble was experienced due to the breaking of frames. New frames of deeper section were secured; Hotchkiss drive was installed instead of radius rods, and new trucks were built up, using the other old units. The four sample AA trucks covered in all about 16,000 miles. One of them was tested out by the Medical Corps as an ambulance. After the Motor Vehicle Board had standardized another type of vehicle for ¾ to 1 ton service, the testing of Class AA sample trucks was discontinued. Later on, two of these sample trucks were turned over to the Post Office Department in Washington, where, it is understood, they are still giving satisfactory service.

#### MOTORCYCLES AND BICYCLES

While the line of motor trucks was being developed by the Quartermaster Corps engineers at Washington in the latter part of 1917 and the early part of 1918, other engineers were engaged in developing a standardized motorcycle and a military bicycle. Four sample motorcycles were given a short road test in May, 1918, before being entered in the Motor Vehicle Board tests. The standardized machine developed important structural weaknesses in tests and it was not put into production. Experimental work was continued on it, however, and later in the summer two of the samples were sent overseas for trial and observation.

Early in 1918 the design for a standardized military bicycle was developed by the Quartermaster Corps, since it was believed that a heavier and stronger machine was required than any then on the market. A series of 24-hr. tests was run early in May on this standardized bicycle. The test course included the ordinary roads around Washington and also some rough cobblestone streets. This standardized bicycle gave trouble and was never put into production. In the early fall of 1918 the design was revised and plans were made to try out samples. This work was never completed because of the signing of the armistice.

With the establishment in April, 1918, of the Motor Transport Service, which took over practically all the motor vehicle work of the Army, the activities of the Experimental and Testing Section expanded. All the testing was centralized at Camp Holabird and the tests formerly made at Marfa and Fort Sam Houston, Texas, were discontinued. The motor vehicle activities of the Signal, Aviation, Engineer, Medical and Ordnance branches of the service were gradually absorbed by the Motor Transport Service, although in some cases this took considerable time. The most important work done in the summer of 1918, however, was the tests made for the Motor Vehicle Board, which are referred to later in this article. Samples of all the vehicles standardized by this Board, including motor trucks, passenger cars, motorcycles and bicycles, were assigned to the Experimental and Testing Section and kept in operating condition. Then when complaints were received either from over-

seas or from military users in this country, it was possible to study the difficulty immediately.

In the summer of 1918 the Section continued the road testing of Class B production trucks. The road tests of the four-wheel-drive Militor or Class TT truck were also started; this vehicle was ready for production when the armistice was signed. The Section also handled considerable experimental construction on special vehicles, such as trailers, horse-transport bodies, snow plows for cantonments, and a wrecker truck for use overseas in salvaging Motor Transport vehicles.

Just before the armistice was signed the overseas requirements for trucks were so great that it seemed every possible source of supply might have to be utilized, regardless of standardization. The standard vehicles were being produced in factories of limited capacity, and tools and fixtures needed to create other sources of supply were lacking. It seemed impossible to secure the necessary tools, so that the purchase of commercial vehicles already tooled up for production was considered. Road tests were started of several of these commercial trucks and some 6000 miles were covered.

#### TESTING OF PARTS AND EQUIPMENT

The class B engine and the Army composite carburetor were developed in the laboratory in its early days. Several important changes were found necessary as a result of the engine tests; the oil relief valve was altered to secure a more constant pressure, the compression ratio was corrected, and the two ignition systems, used for the first time on a truck engine, were synchronized. Overheating of the pistons was detected, as was also the presence of a steam pocket in the water jacket.

The first experimental composite carburetors were of the angle-jet and triple-jet designs. There was practically no difference in the consumption of fuel, but the engine horsepower was increased when the triple-jet design was used. The new carburetor also gave more power than the commercial types available and it was decided to go ahead with it. Word was then received from overseas that the carburetor should be non-adjustable. A set-jet was developed and incorporated in the design of the composite carburetor. As a final check, a convoy of Class B trucks moving from Buffalo, N. Y., to Camp Holabird, Md., was equipped with equal numbers of three different carburetors, two of commercial design and the third the composite carburetor. The results were strongly in favor of the last and it was adopted as standard equipment for the Class B truck.

The testing work at Washington was confined to devices being considered for the standardized military trucks, and anything that appeared worthy of a trial for other reasons was referred to the testing organization in Texas. It was found that some of these devices could be tried out on the trucks under test at Washington, but it was often necessary to use some quicker method of determining their value. Special appliances, such as a mechanical vibrator, were therefore installed in the laboratory. This vibrator was arranged so that hub odometers and similar instruments subject to severe vibration would be given a continuous series of jolts, and their recording or other functions tested at the same time.

Practically all the standard makes of spark-plugs, and a few of special design, were tested in the laboratory. The work given the plugs in these tests was undoubtedly more severe than they would get in actual service. In the impact test the plugs were screwed into a steel block, which was fastened at the end of an arm, arranged to

fall upon a piece of steel rail. This test indicated the effect of vibration on the gas-tightness of the plugs. From 2500 to 50,000 blows were required to break down the plugs. It is believed that assembled plugs should show no mechanical damage after 25,000 blows.

The plugs were subjected to 25,000 volts, alternating current, and practically all stood this electrical test without flashing over or puncturing. In another test the insulator was heated to 300 deg. cent. and dropped suddenly into water. The plug was then examined for cracks and 10,000 volts, alternating current, applied. Most of the plugs performed well in this test, although those in which the porcelain was ground against the central electrode became loose. In the test for gas-tightness the plug was usually subjected to an air pressure of 225 lb. per sq. in. at 200 deg. cent. temperature. The leakage of air varied from 0.27 cc. to 1.66 cc. per sec. Excessive gas leakage and at the same time abnormally high electrical resistance were shown by plugs without cement around the central electrode, thus giving contact between the electrode and porcelain only at the ends.

Radiator protection has been studied at considerable length by the Engineering Division. It is specially important because American motor trucks have had to operate in the interior of France, where it is extremely cold in the winter months. Anti-freeze mixtures of the proprietary type and made from well-known compounds have been tried. Many of them contained calcium chloride, which exerted a corrosive action when mixed with the cooling water. Wood alcohol and glycerine solutions were also considered. The latter was found to be more effective, since it would prevent freezing of the cooling water at a lower temperature than the wood alcohol. There were certain disadvantages connected with the use of both these solutions. The rapid evaporation of the former and the need of the latter in manufacturing munitions made it desirable to seek other remedies. A series of tests was started on the trucks operated by the Testing and Experimental Section to determine the effect of calcium chloride and of sodium formate, used by the French, when added to the cooling water in clean radiators.

Methods of heating the interior of the hood were also tried, the most hopeful results being obtained from a single-coil gasoline heater. This consisted of a long coil of copper tubing heated by a two-tier flash-type burner. It was mounted near the water-pump, connections being made from above the pump to the side of the water-jacket just below the cylinder-head. This and other promising devices were tried in a cold storage room into which the Class B truck was driven. In one test the heater was lighted immediately after the engine was stopped and the temperature was lowered from normal as rapidly as possible. In another, the heater was lighted after the engine and cooling water had become thoroughly chilled. In the first test the engine was started after considerable time had elapsed, while in the second only the value of the heater for starting was determined. In both the engine could be started easily at temperatures as low as 12 deg. fahr. Below this the results were not reliable, because the heat generated by the heater itself had an appreciable effect upon the room temperature. No hood or radiator covers were used in the tests, although they would probably be required outdoors in the wind.

A device to prevent sand, dirt and other foreign matter from being carried through the carburetor into the engine is particularly important for trucks used in con-

## ENGINEERING DIVISION OF THE MOTOR TRANSPORT CORPS

197

voys, when the vehicles at the rear often run through miniature sandstorms. Experiments in the laboratory of the Engineering Division developed a cleaner that would not retard the air-flow into the carbureter and would still eliminate foreign matter efficiently. A cleaner of the inertia type was the most promising, although the tests showed that many changes in construction were necessary. After being redesigned by the Engineering Division the cleaner was adopted for use on the Class B trucks.

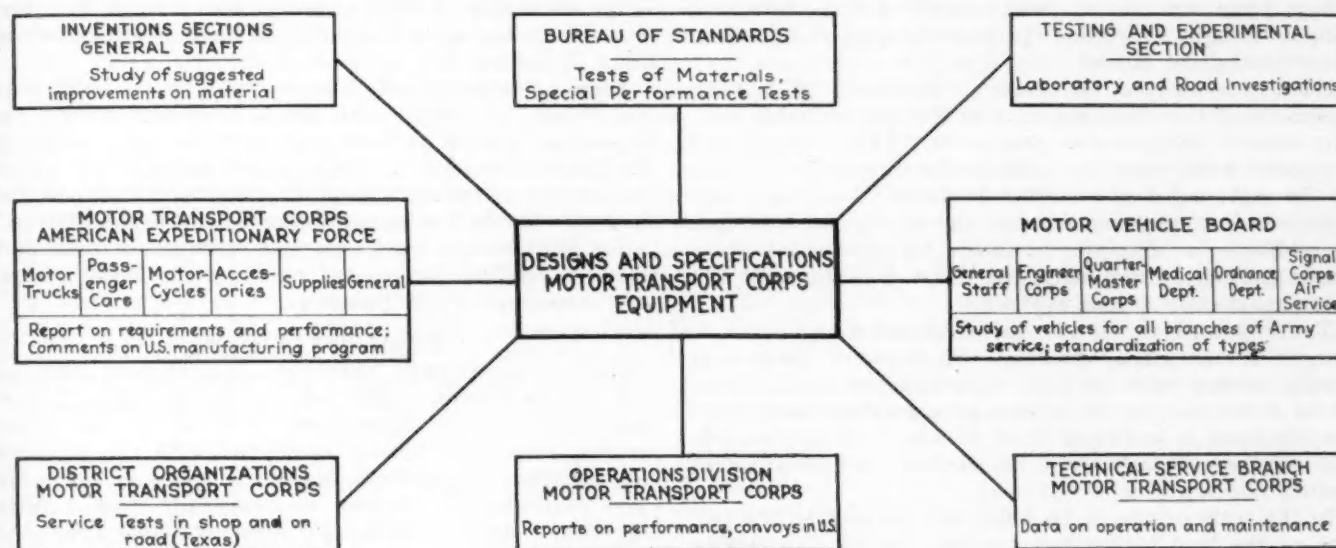
Gasoline lines or tubing often give trouble in heavily loaded trucks, which are subjected to terrific vibration in running over rough roads. Different types of tubing were tried out on the sample trucks by the Engineering Division and it was found that most of the failures were due to chafing against the sharp edges of the dash sill. The trouble was overcome by placing small braces at the points of greatest vibration. Many samples of tubing were also tested to determine breaking pressure, one

included trials of luminous disks, mounted in standard lamps to obtain light visible only at a short distance. These disks were tested to determine how much of their radiance would be lost over a period of time and whether the material would flake or disintegrate when used on motor trucks. No change could be detected in the luminescence after the disks were kept in a dark place for five weeks. The vibration test was made of the complete lamps with disks. This test was continued 5 hr. at a rate of 2400 vibrations per min., with no signs of disintegration.

## MOTOR VEHICLE BOARD

In April, 1918, the Chief of Staff of the Army appointed a board of officers representing the different branches of the service to study the types of motor vehicles, reduce the number of types and secure maximum interchangeability of parts. The recommendations of this board, after being properly approved, formed the

## EXPERIMENTAL SOURCES



## OPERATION SOURCES

CHART SHOWING THE VARIOUS SOURCES FROM WHICH THE MOTOR TRANSPORT CORPS HAS OBTAINED INFORMATION REGARDING THE PERFORMANCE OF EQUIPMENT

end being plugged and oil forced into the other.

On the very front lines all Motor Transport Corps work was done at night in absolute darkness, not even a lighted cigarette being allowed. Some method of lighting was necessary, therefore, so that the trucks could operate safely in convoy without giving any clue to enemy aerial observers. It was found that the light from a blue glass simulated moonlight and therefore gave good protection. Several devices were tried out in which the source of light was protected and the beam was colored; there was sufficient light for driving and still the beam was protected so that enemy observers might mistake it for something else.

Another device mounted just above the driver's head was arranged to throw a narrow band of light directly in front of the truck. When properly adjusted this was sufficient for driving and could not be seen more than 100 ft. away. Variation of battery voltage, however, might increase the illumination so that the light could be seen at a considerable distance.

Tests on tail lamps for use in the theater of operation

basis for all the work of the Engineering Division. Since the board was not a technical organization, it immediately secured competent technical assistance. A comprehensive schedule of experimental and road test work was soon outlined and several test courses were selected. In one the going was specially heavy, the second was over good level roads on which speed "bursts" could be made, and the third was a 300-mile run over the Blue Ridge Mountains in Virginia. It was considered that the last course included all the types of road that the vehicles might encounter in French service.

Starting in May, 1918, a number of separate tests were conducted on motor vehicles. Early production of four-wheel-drive trucks was required and these were tested first; then the three classes of two-wheel-drive truck,  $\frac{3}{4}$  to 1,  $1\frac{1}{2}$  to 2 and 3 to 5 ton, were tested, and finally tests were made of motorcycles and bicycles. Only such equipment as had been actually used by the Army was tried out in these tests.

The preparation for the tests was made by the Experimental and Testing Section of the Engineering Division,

and usually the personnel of the Section carried out the tests, although representatives of other branches of the Army were used as observers. As a result of these tests the board of officers recommended that the Class TT (Militor) four-wheel-drive, the Class B (Quartermaster Corps), the White TBC (Class A) and the General Motors Corporation Model 16 (Class AA) trucks and the Westfield pedal bicycle (military model) should be standardized. In addition, the board recommended that the production of Harley-Davidson and Indian motorcycles should be continued. The Ford, Dodge and Cadillac passenger cars were standardized, as were also trailers, tanks and other types of special equipment.

The Class TT truck was recommended as a standard after a thorough test alongside of two other four-wheel-drive trucks. The Class TT was found to have the ability to do anything on or off the roads that the other two could. In addition it had ability not possessed by either of the other two, such as backing out of mud-holes, gullies and other difficult going. The Class TT design is based on that of French four-wheel-drive trucks which have been under development several years, and also is thought to include the best features of American four-wheel-drive trucks.

The tests of the heavy cargo trucks, 3 to 5 tons, showed that the Class B type was the most suitable military vehicle for average road work. The B truck was compared with two other high-grade commercial vehicles of the same capacity and both fuel and oil economy and ability in heavy going favored the Government design. In addition to this, the facilities for production were much more extensive with the Class B than with the other heavy-duty trucks available.

The 1½ to 2 ton trucks tested included the Class A and four commercial models. These were given unusually severe runs on both solid and pneumatic tires. Three of the commercial models gave results closely comparable from a technical point of view and it was felt that any one of them could be selected with equal satisfaction for army service.

In the tests of the ¾ to 1 ton vehicles nearly 200 per cent of the load rating was carried. In all, five trucks were tested, of which three were commercial models. The final decision was based on the consideration that the Class A vehicle would be used largely for ambulance service and that light weight and low gasoline consumption would be required.

Motorcycles and bicycles were given severe tests and, while the samples designed by Government engineers were submitted for test, it was found that neither in construction nor general performance were they equal to the commercial models available. All the vehicles recommended for standardization by the board required certain changes in construction to be satisfactory for military service and the detail work of making these was turned over to the Engineering Division.

#### TESTING ON MEXICAN BORDER

It is difficult to estimate the value of testing done during the years 1916 and 1917 on the Mexican border. The experience gained there in operating motor vehicles under the most severe service conditions was certainly an important factor underlying the design of all commercial and military vehicles in the Great War. Reports of all the tests made at Fort Sam Houston and Marfa were available in carrying on the work of the Engineering Division and were extremely valuable in supplementing data on performance received from France.

The first testing in Mexico was started in the summer of 1916 when "demonstrating" trucks were tried out on the 400-mile line of communication between Columbus, N. M., and Colonia Dublan, Mexico. At that time a board of officers was appointed to make recommendations on all vehicles under demonstration. Following this the method of testing was systematized, and in the year 1917 many motor trucks, passenger cars and accessories were sent to Texas for test. Complete vehicles were tried out at Marfa, Texas, at the base quartermaster depot supplying army posts scattered along the Mexican border. Attachments and accessories were tested at the repair shop unit in Fort Sam Houston, Texas, where a number of motor vehicles were in use at the headquarters of the Southern Department of the Army.

When the testing connected with the standardized motor trucks was started in Washington, late in 1917, it was found desirable to continue the Texas testing on devices requiring shop or road use, particularly in the case of such devices as were required by the Army for other use than on the standardized military trucks. When the Motor Transport Service was formed the activities in Texas were discontinued and concentrated at Camp Holabird, Md.

Some of the devices submitted early in 1918 were still being tested when the Motor Transport Corps was formed in August of that year, and the work therefore was taken over by the district organization of the corps. The source of performance intelligence, shown on the chart as "Motor Transport Corps district organizations," refers therefore to the shops and other motor transport activities in Texas as carried on under the Motor Transport corps and its predecessors.

#### OPERATIONS DIVISION

The convoy system which was established early in 1918 for delivering motor vehicles to the Atlantic seaboard has supplied valuable technical data to the Engineering Division. Officers connected with the Division have accompanied convoys, especially those of the early Class B production vehicles, and carefully studied their operation. Reports have also been available from the convoy commanding officers, and these supplemented the data obtained from road tests made directly by the Engineering Division. The operation of convoy vehicles for long distances across country and with comparatively untrained personnel often brought out troubles that would not otherwise have been detected. Many valuable suggestions were made from the point of view of operation and applied in the design of the Class B trucks.

In the summer of 1918 the Experimental and Testing Section studied the possible methods of carrying a crated Class A truck on the Class B vehicle. The smaller vehicle was to be crated at the factory according to standardized methods and then carried overland in the B truck convoys. The latter would be crated at the seaboard for shipment.

#### ACTIVITIES OF TECHNICAL SERVICE BRANCH

The work of the Technical Service Branch of the Engineering Division was outlined in the January issue of THE JOURNAL, but it seems appropriate to conclude this discussion of performance intelligence by mentioning some of the specific activities. Its main purpose was to provide cooperation with the different Army users of motor vehicles in any engineering matters developed in maintenance and operation. The information obtained was used to work out improvements in design or to develop designs to meet new service conditions.

If a defect develops in vehicles operated in convoys, at the camps in this country or in the zone of action overseas, the maintenance organization is immediately confronted with problems of upkeep and repair and is also concerned with the adequacy of the design. If an investigation shows that conditions of operation and maintenance have been reasonable, then the problem is immediately referred to the Technical Service Branch. The Branch, in other words, handles only problems of a strictly engineering nature.

An example of this work is offered by the breakages and service troubles encountered in the steering mechanism of a certain vehicle. Troubles of the same sort were encountered both in this country and overseas and it was determined that they were due to difficulty with design. The investigation made of this problem by the Technical Service Branch included a study of the blueprints of the parts affected, of the trucks in service at a number of different camps in this country and a consultation with the engineers of the factory manufacturing the truck, at which experimental designs already subjected to road tests were considered. It was determined that the difficulty was due to the size, design and method of machining the steering-arm and to the type and design of the steering knuckle-pin bearings, which were of the taper roller type and unsuited to the service demanded of them. The steering-arm was increased in size and the method of machining changed to do away with the sharp corner at which many breakages had occurred. The Technical Service Branch recommended that defective bearings in trucks already in service should be replaced, a large supply to be provided at the different maintenance bases for this purpose. Special attention was to be given these bearings, so that they would always be kept overlubricated. For future production two bearings were recommended, the first to take the radial load and

the second the vertical thrust. The Technical Service Branch kept in touch with this matter while new drawings were being prepared in the Design Section of the Engineering Division and then watched the tests of the first experimental design. The procedure would be to try out this new design and as soon as it proved satisfactory, incorporate it in all subsequent production and also use it for replacements.

The Technical Service Branch was also charged with the duty of cooperating with the Training Division. A board of three members, one from the Technical Service Branch, and one each from the Maintenance and the operations divisions of the Motor Transport Corps, was formed to assist the Training Division in laying out courses for training drivers and mechanics. The Technical Service Branch representative would act on the Board to see that the engineering portions of the lecture courses were correctly presented.

The immense number of motor vehicles now under the control of the Motor Transport Corps must, of course, be kept in proper operating condition. Even during times of peace there will be a great deal of work for the Technical Service Branch. While the peace-time organization of the Engineering Division has not yet been completed, plans are already under way to continue the work of the Technical Service Branch by dividing it into testing and maintenance liaison sections. The latter will be represented at all the important maintenance bases of the Motor Transport Corps. The reports submitted by these representatives will be checked, and suggested improvement tried out by the Testing Section already mentioned. This is only one phase of the future work of the Engineering Division, but it is indicative of the thoroughness with which the Division will approach motor transport engineering problems.

## NEW YORK-PHILADELPHIA TRUCK HAULING

**T**HIS country has just awakened to some of the new phases of transportation upon which our future business structure will depend. Various guesses have been made as to the amount of average daily tonnage hauled between New York City and Philadelphia. A conservative estimate seems to be something in excess of 2000 tons daily.

One of the great benefits credited to the war has been the development of the highway transportation industry. One year under war pressure has exceeded the normal development of a decade. Far-sighted business men with ample financial backing have seen that the motor truck is to become one of the principal means of transportation for hauls of less than 150 miles, and in some cases of much greater distances. Companies have been incorporated, fleets of standard makes of trucks have been purchased; receiving and delivering stations have been established; agents with regular assistants have been placed in charge; regular bills of lading or express receipts, showing the carriers' liability, are issued to the shipper on the receipt of each shipment; all rolling stock is under the direction of the chiefs of operation, and regular time schedules and routes are maintained. A shipper can feel safe in entrusting his goods to such a transportation system.

The department of operation is responsible for the condition of all trucks and must maintain the time schedules set for movement between cities. This department is well

equipped with its own garage and repair shop, in which every truck is cleaned, oiled and inspected after each trip. The department is also in position to take care of the time schedule and replace any truck which might go out of order on a trip.

The department of receiving and distributing is responsible for issuing the proper receipts, and sees to it that all shipments are properly picked up, routed, and delivered in good order without delay. This department has under its charge, in both Philadelphia and New York City, a fleet of smaller trucks which are more suitable for city work because of their greater speed and flexibility.

The auditing department checks over all bills of lading, all receipts, expense accounts and payrolls. The findings of this department are used in formulating rates.

The maintenance of all these departments has been found necessary to offer the shipper a safe method by which he can quickly get his goods from one city to another. From our experience as shipper and receiver we feel that for shipments between New York City and Philadelphia motor-truck transportation is not only the quickest, but also the most economical and satisfactory means of moving merchandise, food and factory supplies, when the weight of the shipment is less than a carload; and even in some such cases of large shipments we say ship by motor truck.

WILLIAM ARROTT.

# Commercial Flying

**F**ORTUNATELY for the aeronautic industry, approximately \$10,000,000,000 has already been invested by European, American and Asiatic countries in aeronautics. Part of this has been expended in constructing aircraft factories, engines, airplanes, dirigibles, hangars; in obtaining raw materials and landing fields; in training aviators and mechanics and in making the necessary machinery, equipment and accessories. Thousands of furniture and piano factories, boat-building shops and similar establishments have been manufacturing propellers, struts, ribs, pontoons, flying boats, and so on; and hundreds of automobile makers and engine manufacturers have given over their plants, or a good portion of them, to making engines, spars and tools.

Varnish, linen, cotton, castor oil, goggles, clothes and a hundred-and-one other things have also been used either in the direct manufacture of aircraft or in the equipment of the aviators and mechanics, so that there are today tens of thousands of skilled and unskilled artisans, aviators, mechanics, who are wondering if the airplane engine, with its remarkable development from 16 hp., which the Wright brothers used, to the 700 hp. of the Fiat, will be extensively used in commercial flying, and if the frail little Wright glider, which has grown into a machine weighing 6 tons, can be made a profitable means of transportation.

They also ask what is going to be done with all this scientific knowledge and trained technic; with the enormous investment in fixed property and the tens of thousands of aircraft built or building. Are they to be abandoned like a poison-gas factory, or are they to solve the problem of rapid passenger and freight transportation?

The best answer is to be found in what is already being done to make the airplane do man's bidding as easily and as readily as the steamboat, electric car, steam engine and automobile.

Even though the airplane does travel the shortest route in the shortest time between any two given points, before a sufficient number of passengers can be induced to travel via an aerial line to make it financially profitable to the transportation company the public must be assured that it is reasonably safe, that they can fly in comfort and that the charge is reasonable. So let us first see what has been done and what is being done to meet those three requisites.

The dangers of airplane flight have been grossly exaggerated by newspapers, which record only the unusual. Moreover, flying in the war zone was done under the most adverse and dangerous conditions. The machines were built for maneuvering ability and speed, and not for stability and safety. Furthermore, all the air scouts and most of the reconnaissance and battle planes were driven by only one engine so that if engine trouble developed they had to volplane to the ground at the mercy of enemy guns and fighters. Finally, they often had to land in shell-scarred terrain. Naturally the casualties were high. Indeed, war in the air was meant to be perilous.

## CAUSES OF ACCIDENTS

Nevertheless, in spite of these hazards, it is remarkable how many machines, even when shot down with some essential part out of commission, in many cases falling several thousand feet, have righted themselves before reaching the ground and have made a safe landing, due to precision and accuracy of construction with regard to lateral and longitudinal balance. And all in all, judging from the wonderful records already made by airplanes, even the single-engined machine is very reliable.

With the twin-engine plane casualties were, of course, not so high, for even if one was put out of commission the other could bring the aviators back to the hangar. Major Salomone, the Italian Ace, on Feb. 20, 1916, flew 100 miles back to his own lines with one of the engines on his Caproni shot out of commission.

On the aviation training fields, owing to the novices who

were learning to fly, the natural recklessness of youth, and sometimes the faulty construction of planes—hastily built and often superficially inspected—the casualties have been higher. Stunting too near the ground and in machines constructed primarily for straight flying so that the stresses should come from only one flying angle, enemy treachery, and the absolute necessity of discovering the best maneuvers and trying out the newest types of airplanes, have also augmented the honor roll. But, stunting eliminated—with machines equipped with two or more reliable engines, built according to standardized specifications as to materials, methods, stability and the required number of safety factors, steered by tried and true pilots, flying between regular landing fields and hangars, and directed from the ground in dark and in foggy weather by radio telephones—the dangers of flying can be reduced to proportions commensurate with the desire of the public to get from place to place in the quickest and safest vehicle.

Of course, the present high landing speed of an airplane is the cause of many accidents. Thirty-five miles per hr., except where the head resistance is great, is the slowest speed now made in landing a heavier-than-air machine. The invention of a device or the discovery of a means of reducing the speed to 10 miles per hr. when touching ground, though still only in the realms of the probable, is by no means opposed to the inherent laws of the airplane. This accomplished, the danger of flying in an airplane will be reduced to infinitesimal proportions—at least to a degree no more precarious than riding in an automobile.

Already the War Department has ordered flyers to map the country. The Wilson Aerial Highway, from New York to Chicago and San Francisco, has been laid out. Aerial transportation companies will soon be formed to provide planes. Thousands of skilled pilots are looking for jobs; many chambers of commerce will build landing places near their towns and cities. Needless to say, laws will be passed to prevent stunting with passengers and requiring machines to fly at the altitude necessary to glide to the nearest landing place in case an engine stalls. Already a dozen different engines have been developed which will run 24 to 100 hr. without stopping. Recently the Caproni biplane at Mineola, Long Island, climbed to 14,000 ft. with one of the three engines completely shut off all the way.

Thousands of sensational flights have been made, in all kinds of weather and under the most adverse circumstances of a great war. Of the hundred-odd air raids on London by the Gothas some were conducted in daylight, when the Germans had to fly through squadrons of British scouts and fighters, through or over three barrages, in order to get to the metropolis; and yet seldom more than one or two Hun machines out of the thirty usually constituting the squadron were forced to land or were shot down. The same thing was true of the British Independent Air Force in the raids it made over German cities, citadels, factories, ammunition dumps, and other military objectives, though the fleets often numbered 50 to 100.

Of the 350 machines constituting the American air raid on Waville, in October, only one airplane failed to return, though twelve Hun machines were shot down. The German flying tank which shot down Major Lufbery, the American Ace, was driven by five engines, which were protected, as well as the fuselage, with bulletproof steel  $\frac{3}{4}$  in. thick. Major Lufbery emptied his machine gun against this aerial monster from close range and from many angles before his gas tank was pierced and his machine went down in flames. Therefore, a two-engined machine, flying under peace conditions, should be able to make its landing safely nearly every time.

## DISCOMFORTS OVERCOME

There were three discomforts in air travel—the cold, the noise of the engine, and the lack of space to move about. Electrically heated clothes eliminate the cold; acousticons,

## COMMERCIAL FLYING

201

which shut out the noise, yet permit the passengers or aviators to converse together, have already been devised, and are in universal use on airplanes. With the increase in size of planes and number of engines, the nacelles and enclosed roomy cabins can be constructed as they were on the famous Sykorsky aerobus, built in Russia before the war. This plane carried twenty-one people to an altitude of 7000 ft. On this trip they had ample room to move about and to observe the sky and the landscape. On Thanksgiving Day last, a half dozen guests of an American aircraft factory had their turkey dinner served in a huge plane above the clouds.

It is true that owing to the cost of airplanes and engines, their upkeep and the number of skilled men required to fly and maintain them, all air travel is expensive. The two-seater training machines equipped with one engine cost \$5,000 to \$7,000, and the huge twin-engined bombing machines averaged \$40,000 to \$60,000. This price was due to the necessity for hurried construction; for everything that went into the building of the engine and the machine itself, and also for labor, the very highest price had to be paid. Tools, machinery, factories, fields, hangars, and a thousand other things, had to be purchased, and a great body of skilled workmen had to be trained before aircraft could be turned out in quantity.

Now all this skill and billions of money have been invested in the industry, so that the plants in this country are ready to manufacture nearly 200 planes a day. With this nucleus to start a peace-construction program, the price even of the biggest machines must soon shrink to that of a high-priced automobile or private yacht. Plenty of sporting machines, with small wing spread and a two-cylinder engine, that will sell for \$500, are now being made; and since these machines can average 22 miles per gallon of gasoline, the expense of maintaining one will not be beyond the means of hundreds of the young flyers now returning from beyond the West Front. Moreover, since there will be no maintenance of roads, rails, live wires, and so on, such as there is in the railroad and electric road industries, the cost of maintenance will be definitely smaller, so that aerial travel may in the end become cheaper than any other known to man.

Fundamentally, the hydroplane is the same as the airplane, except that pontoons instead of wheels are used to land upon. The cost of these airships over the land machines is noticeable only where boats are used instead of pontoons, consequently their price above that of the airplane will depend on the size and kind of furnishings used in the boat. Owing to the fact that no landing field has to be bought and maintained, and that the flying boat can be landed on a river or lake with comparative ease, and also the fact that altitude does not have to be maintained to glide to a safe landing, this type of plane navigation bids fair to be fast, cheap, and absolutely safe. Moreover, the size and passenger-carrying capacity of these flying boats will be limited only by the construction of wings strong enough to maintain them in the air, for the size of hulls and the number of engines can be increased indefinitely.

Perhaps the best indication of what we may expect of the airplane as a commercial carrier is shown in the present plans of the manufacturers. Using the past history of the heavier-than-air machine performance, and their own experience and that of thousands of flyers under all imaginable circumstances and conditions as a basis, they are building various types of aircraft. More than a score of American and British firms have already built and are putting upon the market large numbers of sport models. These machines are single and double seaters, after the type of the famous baby Nieuports, Spads and British Sopwith pups. They have a wing spread of anywhere from 17 to 30 ft. The fuselage measures between 10 and 20 ft. Some are equipped with one small engine generating from 20 to 40 hp. The whole machine will not weigh more than 500 lb., and these models are able to fly at 80 to 100 miles per hr. and make an average of 20 miles or more per gal. of gasoline. The price of these will depend on the demand, but most manufacturers believe they will sell for \$500 to \$1,000. These machines are so small that they can be landed on any road or field, and the

small amount of space they take will make it possible to house them inexpensively. They can be used for any kind of cross-country flying or sporting purposes.

## THE SPORTS TYPE

Another type of sport model has a wing spread of 26 to 38 ft. These wings can be folded back so that the plane can be housed in a hangar 10 by 30 ft., with ample room for the owner to work indoors on the machine. The fuselage is proportionately larger than that on the smaller machine. This plane is equipped with a four-cylinder upright engine or an air-cooled rotary engine of the Gnome style, with nine or eleven cylinders, generating up to 90 hp. Some also have two small 20-hp. engines geared to the one propeller, so that they can be throttled down, or in case one stalls the other can take the flyers to their destination without being forced to land. Some models have two engines on the smaller machines. These will sell for about the price of a medium-cost automobile.

The two-passenger models are similar in design to the army training machines. They have more powerful upright and V-type four or eight-cylinder engines and generate 200 to 300 hp. The fuselage is built so that the pilot sits in front of or beside the passenger. The control is dual. The machines are for the most part tractors, but in a few cases the nacelle is built in front of the plane like a bomber, and the propeller and engine are behind. These pusher types obviate all the blind angles and afford an excellent, unobstructed range of vision. They are especially good for hunters, who desire no obstruction in gunning for birds. In case of a crash, however, there is the added danger of having the engine crush the passengers underneath.

The air-mail type is about the same as the two-passenger model in wing spread and fuselage, but the engine is a twelve-cylinder V-type, and generates anywhere from 250 to 450 hp. Cost is not so much a consideration here as carrying capacity. Most of the two-seated fighting machines built for war purposes can be used by the Post Office Department for this purpose, and plans are now being made to extend the service all over the United States.

The big bombing bus type is designed for carrying great numbers of people from one airdrome to another. These machines are biplanes and triplanes with a wing spread of anywhere from 48 to 150 ft. They are driven by V-type, twelve-cylinder engines generating 400 to 700 hp. They have one or two fuselages in the center, but the nacelles are usually forward of the wings so that nothing obstructs the vision of the passengers. These machines will be sold to transportation companies, which will make a business of carrying people from aerodrome to aerodrome. They are so large and are equipped with so many engines that they are not intended to land anywhere except on properly prescribed flying fields.

All the above types of aircraft are so designed that pontoons or flying boats can be substituted for wheels and landing gear, and so that most aircraft manufacturers can make both. Of course, in most cases the boats and the engines are made by different manufacturers. Several companies, however, construct airplanes complete with engines.

Naturally, no manufacturing industry can exist without a potential market. Aircraft manufacturers are certain that a majority of the 20,000 flyers and 100,000 aero mechanics who have learned their trade in the great war will want to fly either machines of their own or of somebody else, or of some trans-aerial company. The airplane engineers have, therefore, designed the sport type for the young fellows who wish to race in the air, travel from country town to country town, from lake to river, or to commute from country to city. Since these machines fly faster than the fastest bird or the fleetest animal, they will afford great sport for gunners. Indeed, the machines have already been used with such disastrous effects upon the bird that many hunters say it is not good sportsmanship to hunt from them. In that case, perhaps the farmers will hire the daring young aviators to hunt down the crows and hawks with these dragons of the air.

Be that as it may, this sport type will be a great convenience for a person who works in a city beside a large lake or on a river, and who wishes to live far in the country. Indeed, he may live 100 miles up or down that body of water and in less than an hour can fly to or from his work. If it is cold he can put on his electrically heated clothing and keep as warm as in a limousine. If he has engine trouble, he can land anywhere to fix his machine and then fly on. Since air resistance is much less than road resistance he can traverse the distance much cheaper than in even an inexpensive automobile. If there is no body of water near his place of business he can land his cross-country flyer in a park or flying field just as easily as on the water. This same machine will lend itself to all kinds of pleasure flying, and no other sport gives so much exhilaration, scenic view and adventuresome excitement as the airplane. The price will be within the means of many young men. The two-passenger models will be sold to people of means who have flown or wish to fly and take up friends. After a few years the manufacturers expect there will be a considerable body of these enthusiasts. The greatest sale of these machines, however, will be to the government for the air-mail service. At first, two machines will be needed for every flyer in this service, and one in every aerodrome for every one in the air, so with fifty established routes we shall require several hundred machines. Moreover, the manufacturers expect that these machines, fitted with either a fuselage or a boat, will be employed very extensively by mining companies for carrying precious metals in South America and Alaska. At the present time llamas are used to carry copper down from the Andes. They are so slow, and have to descend to the smelters by such devious routes, that valuable time is lost in the transportation. By loading the ore into the hold of a flying boat, which can land on the lakes and ponds in case of engine trouble, the time will be so materially diminished as to reduce the cost of the metal very considerably. Besides this, flying in a straight line as the bird flies, at a speed of not less than 100 miles per hr., will expedite the work of the engineer and surveyor over the jungles and unexplored and inaccessible portions of South America and Africa, as well as in other distant countries.

Conditions in Alaska are analogous, although the climate is

different. Dogs and sleds are now used, and they, too, have to travel roundabout routes from mine to town. Of course, an airplane, fitted with skids or runners, can be landed on snow or ice as easily as on land. It now takes two days to sled gold down to Nome from one mine in the Yukon, while this could be brought out in 3 hr. by airplanes flying over the tops of the mountains.

In conclusion, it may be safely laid down as an axiom that the conveyance which reduces man's time in traveling from one place on this globe to another will sooner or later be adopted by him. No matter what the discomforts, the dangers or the expense may be in the beginning, he will eventually find a way to change the inconvenience into luxury; the expense will be reduced to within the means of all who travel, and the danger will be diminished to infinitesimal proportion. It was thus in the beginning, it will be thus till the end of recorded time. It was thus with the recalcitrant camel, the ponderous elephant, the wild horse. It was thus that man transformed the floating log which he propelled with his feet into a floating palace, driven thousands of miles across the greatest of oceans. He has metamorphosed the puny stationary steam engine into a demon that is more powerful than a thousand horses, which now rushes him across the broad spaces of the earth.

Before long we may reasonably expect that all the capitals of the world will be connected by air lines. Already regular landing places have been established from London via Paris, Rome and Constantinople to Bagdad and Cairo. Peking and Tokio will next be added. The flight from London to New York will also soon be an accomplished fact. Then all the capitals of Central and South America will be joined up. The distance from South America to Africa is about the same as that between America and Europe. By reducing the time of travel between all these places to hours, the airplane will make mountains dwindle into ant hills, rivers to creeks, lakes to mudholes, and oceans and seas to ponds. The globe will be aerially circumnavigated. Tokio and Peking will be as accessible to New York as London now is, and vice versa. There will then be no east or west, and with the new aerial age will come a new internationalism founded on speedy intercommunication and good will toward all mankind.

—Evan J. David in *Saturday Evening Post*.

## THE COOLING OF MACHINE GUNS

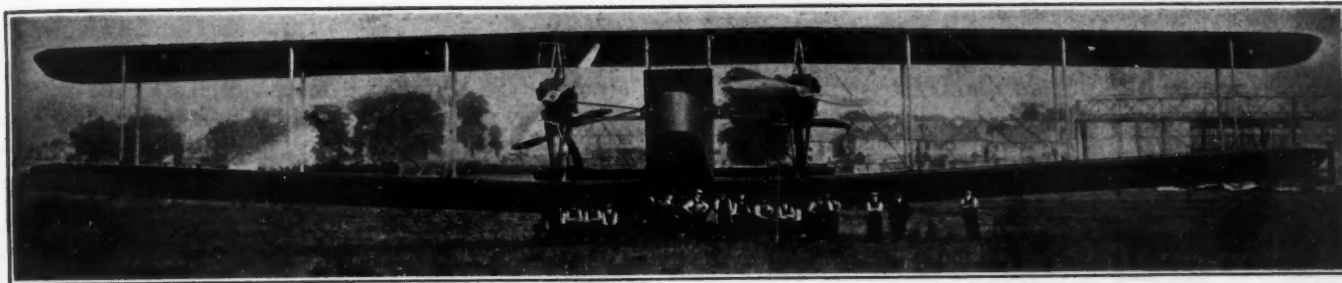
**A**N improvement in the methods of cooling machine guns during continuous fire and the prevention of the freezing of the cooling solution in cold weather while the gun is not in use is sought by the Inventions Section of the General Staff of the Army. The ordinary water-cooling system is employed at present, which necessitates the transportation of several boxes of water for each gun in the field, since the water in the cooling jacket is turned into steam quickly during firing. It is not necessary that the cooling system developed follow the lines of the present water-filled jacket, as

any efficient method of cooling will receive consideration. It should be borne in mind, however, that whatever agent is used should be easy to obtain and transport, cheap, must not injure the metal parts of the gun and should be capable of being used several times to avoid extra weight. A minimum of waste in use is also desirable. Any of the members of the Society wishing to present solutions of this problem should address the Inventions Sections, General Staff, Army War College, Washington, which has charge of all work of this nature.

## PETROLEUM-PRODUCED TRANSPORTATION

**T**HE quantity of oil used in the war zone was very considerable, but it probably did not equal in volume the amount which will now be required to carry on the ordinary affairs of industry, and to supply what will be needed to meet the extraordinary requirements of reconstructing the devastated regions. If, as stated by Senator Berenger, the

petroleum-driven vehicle prevailed over the railroad in time of war, it is reasonably certain that it will be equally useful in peace times. It would not require a very great imagination to visualize a complete system of world transportation operated by petroleum-produced power with some type of the gasoline or internal-combustion engine.—E. L. Doheny.



# Aerial Warfare

By G. DOUGLAS WARDROP\* (Member)

DETROIT SECTION ADDRESS

Illustrated with PHOTOGRAPHS

**T**HROUGH the stimulus of war, aviation has emerged from the county-fair exhibit stage to become one of the most important units of modern military protection. Four years have witnessed greater progress in aeronautics than any decade has seen in the development of other branches of the automotive science, and with the war now over, every development that has been made can be readily adjusted to the benefit of mankind at peace, for the airplane and the dirigible will be to the present generation what the steamship and the railroad were to the last.

Aeronautic enthusiasts predicted that the airplane would be the most important unit in winning the war, and I am confident that if the war had been carried to a fighting finish the aerial exploits of the spring drive of 1919 would have been on a hitherto undreamed of scale. The fighting end would have come, not so much as a fight between infantry, with machine guns and light artillery equipment, but as a grand affair, with fleets of airplanes and tanks as the prime movers; the two automotive units working in close harmony. The only antithesis of the tank was the artillery; the antithesis of the artillery, the airplane. So that with a dominant air service in every arm of that service the skies would

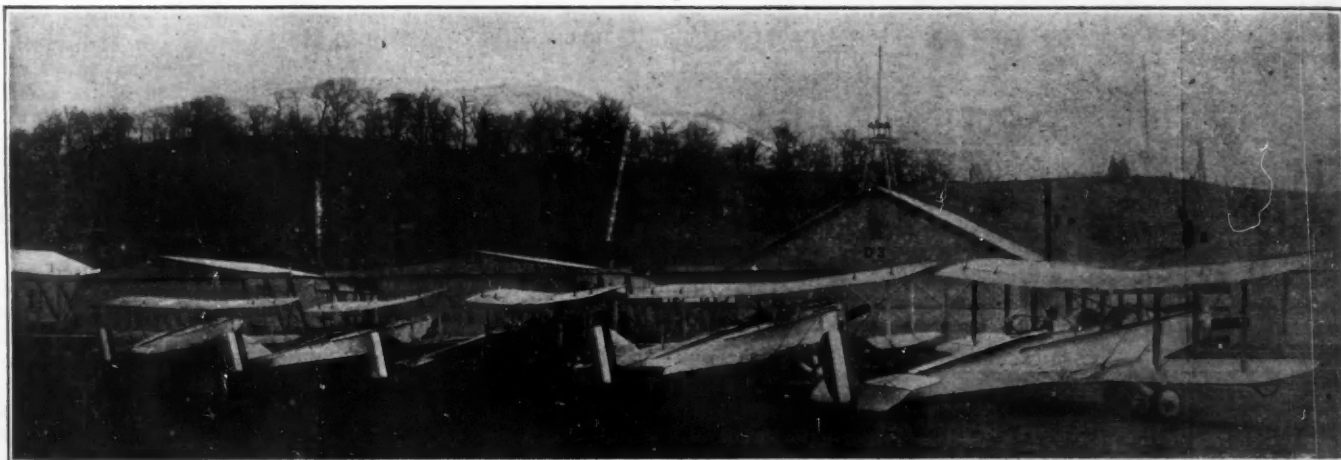
\*Managing editor *Aerial Age Weekly*.

have been cleared of German machines, and in addition to the tanks going ahead comparatively without obstruction, the airplanes could have engaged not only in a minor way in patrol and pursuit warfare—they could have concentrated almost entirely on bomb-dropping, obliterating the railroads, ammunition dumps and supply stations first and then proceeding to the factory areas, putting enough "sand" into the machinery to effectively slow up production.

But though the world was not to see the climax of war aviation, it has awakened to the potentiality of the airplane and the dirigible, and who will negative the prophesy that the air service in future wars will be all-important? Germany in 1914 demonstrated efficiency in mobilization—but the destruction that she did with her Krupps in months will in 1940 be done in minutes by the aerial monsters that will then be with us. In future wars the real conflict will be in the air and the units on land will merely cooperate.

## PART PLAYED BY THE AUTOMOTIVE ENGINEER

The automotive engineer has revolutionized warfare by perfecting the airplane and the land tank, and historically it is interesting to note that the nucleus idea is American in origin. That a prophet has no honor



GROUP OF AIRPLANES BEFORE THE HANGARS AT ONE OF THE TRAINING FIELDS

in his own country was never more clearly demonstrated than by aeronautics in this country from 1914 to 1917. In 1914 the industry got little encouragement, indeed much discouragement. This was the case also when we entered the conflict actively. Private concerns had not been able to bear the expense of experimentation to develop our resources. When it became evident that if production was to be achieved quickly in airplane work types that had been developed by our Allies would have to be accepted and built in our factories, the engineering profession, with great disinterestedness, undertook the task. Events demonstrated that we could do this quickly, and the records of the De Havillands and of pursuit machines on the Western Front in September is practical evidence of our success.

#### DEVELOPMENT OF THE LIBERTY ENGINE

The great American automotive achievement was the development of the Liberty engine for airplanes and tanks. When I saw Air Minister Weir in London, in September, the only thing he was interested in was how many of these engines he might expect and how soon. They had then demonstrated the engine's worth beyond any doubt, and in the mammoth air program that was being outlined for the spring of 1919 the Liberty engine was destined to play an important part, and was to take over German territory not only American but English, French and Italian built machines. There is only one engine abroad that can be compared with the Liberty in the matter of efficiency, while in production this was far outclassed only fifteen months after the first blueprints were made for the Liberty job. This is a record to be proud of, and the engineers who were associated with the development of this powerplant have every reason to be satisfied. Perhaps the only regret they have—and I know from personal contact that our airmen on the other side share this regret—is that the war did not last long enough to bring the peak of activity of the Liberty engine on the Western Front. Those boys were already visualizing radio-controlled squadrons of hundreds of Handley-Pages on the Berlin route, each equipped with four or more Liberty engines.

But while the airmen are dissatisfied that the end came so soon, their regret is somewhat mitigated by the knowledge that out of the chaos of war the one mechanical apparatus that will be of lasting value to civilization is the airplane. Already nations are beginning to think aeronautically. Our airmen are charting this country, and their charts and maps will, we are sure, be referred to more often in aerial commerce than in warfare.

The Post Office Department has been bombarded by

requests from cities throughout the country that they be put on the aerial mail map, and these requests have been largely stimulated by the example of the New York-Philadelphia-Washington aero mail, which has been 100 per cent perfect since the Post Office took it over in July. Airways from the Atlantic to the Pacific have been mapped out, Chambers of Commerce throughout the country are considering municipal landing stations to put their towns in line with modern development. The Navy Department will equip the coast guard stations with aircraft, profiting by the experience it has had with coast and sea patrol. I have had recently letters from lighting and powerplant companies inquiring where they can purchase machines to patrol their lines and waterways. Hundreds of inquiries have come to me from sportsmen outlining their ideas as to aerial craft and asking to be put in touch with manufacturers.

#### POSSIBILITIES OF TRANSATLANTIC FLIGHT

Transatlantic flight has resolved itself into a competition. Various large money prizes are again open, and at least two sportsmen in America have offered to pay the expenses of construction if a manufacturer will build a machine that will make the journey. Several plans are under advisement. In England, the Handley-Page Co. has announced its intention of making an effort; the engineers of the Caproni Co. in Italy are at work on an 18,000-hp. machine for the same purpose, and the Voisin Co. in France, which has cooperating with it the pioneer in large machine construction, Sikorsky, is at work on the task also.

The formidable barriers that seemed to be in the way of transatlantic flight in 1914, when Lieut. Porte was working with the Curtiss Co. have disappeared. Through the excellent work done by Professor Poor of Columbia University, an air pilot can calculate his exact location in a few seconds; the possibility of using radio apparatus and having the aviator "time in" with the Eiffel Tower and then fly directly for it, is under consideration, and the efficiency of the modern powerplant makes the longest lap of the journey an easy flight. With the spirit of competition aroused, and the corresponding increase in engineering efficiency, this journey will without doubt be made early in 1919. There is every reason to believe, moreover, that the North and the South Poles will be reached by an air route in the near future.

After such initial achievements as these the circling of the globe will easily follow and the dream of the future will be of a trip to Mars.

## EMPLOYMENT OF DISCHARGED SOLDIERS

THE Professional and Special Section of the U. S. Employment Service, a branch of the Department of Labor, has been organized for the benefit of employers who are in need of the services of engineers, executives and men of college training and practical experience in business and technical fields, who are now being released from the Army, the Navy and other branches of Government war work. At the present time the work of the section is handled from two offices, one in New York City at 16 East Forty-second Street and the other at 63 Adams Street, Chicago, Ill. The territory covered by the New York office includes the States of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Ohio, Delaware, Maryland, Virginia, West Virginia, North

and South Carolina, Georgia, Florida and Alabama. While the work in the remaining States is handled from the Chicago office at the present time, it is planned to establish zone offices to take charge of parts of that territory later.

The Employment Service has the cooperation of the national technical societies and the offices at New York and Chicago have become clearing-houses for their respective parts of the Nation, where returning men are classified in accordance with their qualifications and the requisitions of employers are matched against them. It is stated that the system of classification is so complete and the qualifications of the applicants so diversified that practically all details can be met. No charge is made to either employer or employee.

## Activities of S. A. E. Sections

FOUR hundred representatives of the various automotive industries outlined their activities for the reconstruction period in connection with the Home-Coming Supper and afternoon technical session of the Society held on Jan. 30 at the Hotel Morrison, Chicago. At the latter George W. Smith, chairman of the Mid-West Section, presided. The shortness of the interval between the afternoon and evening sessions did not permit of much discussion on the various papers presented and it is planned to continue the discussion at the next Section meeting, which will be held on April 11.

After a brief business session A. F. Milbrath read his paper on "A Modified Design of Class B Truck Engine," which will be printed in an early issue. One of the features on these engines is the elimination of aluminum supports on the crankcase, these being now of steel. A cast steel or malleable arm is bolted on the rear of the bell housing and a large trunnion bearing on the iron gear-cover carries the front end. This allows a three-point suspension. The incoming fuel is supplied with heat by casting the intake and exhaust manifolds integral. A new feature on these Wisconsin engines is a system of returning the oil from the front of the engine to the sump on down-grade conditions, thus preventing the front cylinders from pumping oil. Asked whether or not this engine was suitable for tractor use, Mr. Milbrath replied that it was primarily a truck job, owing to the enclosed flywheel construction, but that it could with modifications be used in tractors.

H. L. Horning was the next speaker, his topic being engine performance with certain fuels. He pointed out by curves the performance of a 330-cu. in. engine under various conditions at from 500 to 1000 r.p.m. The Liberty engine output was employed as a starting point; the outputs of the same sized engines of tractors were compared with this. The best laboratory tests engineers might reasonably expect as shown by the chart is 41.5 per cent, while with kerosene the best the engineer hopes for is about 23 per cent. The fluctuations in output owing to leaky rings, bad plugs and other causes may cause it to drop as low as 9.5 per cent, under certain operating conditions, Mr. Horning said. This figure, however, was not to be taken as an axiom. The tractor of the future, according to Mr. Horning, will likely be fitted with some sort of regulating device so that the operator by simply turning a lever to a given position can burn any sort of fuel, whether gasoline, kerosene or distillate. He also exploded the heavy fuel knock theory, stating that his experiments have shown that the so-called "preignition" knock is not due to preignition but rather to the terrific increase in pressure. This knock occurs, according to his observations, about 20 deg. after top dead center. The pressure rises from 900 up to as high as 1300 lb. per sq. in. The resultant heat, however, dissipates very quickly.

Mr. Horning summed up the results of his findings by stating that if we are to burn kerosene successfully the Otto cycle gas engine, the combustion chambers must be redesigned to hold back the explosion pressures.

Mr. Kettering supplemented the talk by Mr. Horning by stating that the so-called carbon knock is not due to the carbon, but rather to the high temperatures and pressure set up by the presence of carbon. In other words, he exploded the idea of the carbon particles remaining in an incandescent form and prematurely firing the charge. Carbon, Mr. Kettering pointed out, makes one of the finest insulating materials in the world and by thus insulating the water-jackets, heat cannot be dissipated to the cooling water fast enough and the heat builds up together with the pressures in the explosion chambers.

At this point in the afternoon meeting E. B. Blakely, who for the last four years has been expounding the Hvid type of engine, suggested that engineers give this type of engine more thought, as it does away with all idea of individual

engine makers having to design their engines for certain types of fuels. The Hvid engine, Mr. Blakely stated, carries what might be called a little still of its own, so that no matter what the fuel in question is, the Hvid engine can handle it, as it automatically adjusts the fuel to the engine.

The paper by J. D. Nies of Lewis Institute of Technology on "Possibilities of Steam Power" brought forth much favorable comment. While the instantaneous generation of steam will never be realized, Mr. Nies, stated that in the steam cars of today the time required to get up steam is very short. The leading difficulties of the early forms of steamers have been overcome, such as scale formation in the boiler, frequent filling of the water tank, etc. He suggested that more attention be paid to the subject of freezing, so that damage as a result would be eliminated. In view of the use of present-day heavy fuels which the steamer is quite capable of coping with successfully, Mr. Nies stated that a considerable extension of the steam car may be looked for in the next few years. He further suggested that steam cars should be so built that the water could be drained from one point. Some day, he said, we may reasonably expect the steam car owner simply to press a button and find steam up by the time he gets out to the garage. The growing appreciation of the uselessness of high speeds on the roads has caused a tendency toward smaller boilers in the steam cars, since these have no bad effects upon the general car performance. The paper is printed elsewhere in this issue and will be discussed at the meeting on April 11.

Capt. Mark Smith, U. S. Marine Corps, related his experiences at Chateau Thierry.

In addition to President Kettering, the speakers of the evening included George W. Smith, chairman of the Mid-West Section; H. H. Merrick, president Chicago Association of Commerce; Col. Chauncey B. Baker, Motor Transport Section, Quartermaster's Department, and William B. Stout. E. E. Peake, executive secretary, National Automobile Dealers' Association, acted as toastmaster. A fuller report of the speeches will appear in an early issue of THE JOURNAL.

In the addresses following the dinner specific facts were driven home by all the speakers. Mr. Kettering suggested that the wealth of available technical information be card-indexed in every engineering office, for progress will be so rapid that the engineer who is not alert to opportunity may let it pass him and then vainly attempt to catch up with it. Besides outlining briefly what the engineers of this country had accomplished before and during the war, Mr. Kettering pointed out some of the remarkable developments that to him seemed the crowning achievements of the country's technical skill. He mentioned the wonderful feats of wireless telephony, whereby one or more airplanes can communicate with each other or any station on the ground. This, he said, is of untold benefit when flying above the clouds, as it gives the pilot his exact location. A chain of these stations on the earth's surface extending across the country would constitute guiding means for the great air lanes that are sure to come.

President Kettering predicted that the time would come when airplanes would be self-guiding, that is, the pilot could go to sleep in his plane if he so desired and be assured that his machine would not miss the point of destination by more than a fraction of a mile. He said this has been done successfully in flights in and about Dayton, Ohio. In one case the plane flew from Dayton to Columbus, Ohio, without anyone touching the control levers and the machine came within  $\frac{1}{2}$  mile of its goal.

While it is true that much valuable information has been gained along aviation lines with the machines developed during the war, such information has still to be supplemented greatly if it is to be of value in commercial life. War machines are no more capable of performing the functions of a commercial airplane than the tank is of agricultural work.



MOTOR TRUCK DINNER AT THE AUTOMOBILE CLUB OF AMERICA, NEW YORK CITY, FEB. 10.

In designing war planes the factor of safety comes last. Everything is done to get utmost efficiency in handling and speed. The latter is the desirable thing in airplane work, whether for commercial or war work, since it is speed that makes the plane economical to use. Mr. Kettering illustrated this point by stating that the distance between Dayton and Columbus is nominally made by train in about 3 hr., while by airplane this is done in something like  $\frac{1}{2}$  hr.

On behalf of the Chicago Association of Commerce, Mr. Merrick welcomed the engineers to Chicago and expressed the thanks which he said every individual, in fact, the whole Nation, owed the engineers of the country in helping to carry the war to successful conclusion. He especially commended the performance of the dollar-a-year men and those who collectively gave their best talents to evolving automotive products for the Nation. In closing Mr. Merrick expressed the hope that the thousands of skilled men still abroad would soon be back in America to pour their additional knowledge into the engineering realm.

Following Mr. Merrick, Col. Baker told the engineers of the great work the motor truck had done in crowding out the army mule. He outlined the introduction of the motor car into the Army in 1903 at one of the national encampments, and that of the truck in 1907. Since those years, Col. Baker said, the motor vehicles have played such important parts in Army work that they are today indispensable. He showed how the trucks had been able to go through Mexican country where roads were totally absent. Special mention was made of the standardization of Army trucks. In the early days of mule wagons, he said, there was no such thing as standardization, so it became necessary to carry a multitude of parts for different sized vehicles, and often these did not fit. With the standardized Army truck it is certain that the springs, for instance, of one truck will fit any other truck though thousands of miles away.

"We are now at the zero hour," said Mr. Stout in his address on the possibilities of the airplane for commercial uses. He pointed out that many people, now that the war is ended, are of the opinion that aircraft development will lose much of its momentum gained in the last year or two. To offset this Mr. Stout stated that the aircraft producers are simply preparing for a commercial attack. Like Mr.



THE "HOME COMING SUPPER" OF THE SOCIETY OF



THE SOCIETY OF AUTOMOTIVE ENGINEERS AT THE HOTEL MORRISON, CH



N, CHICAGO, JAN. 30.



Kettering, he said that the war machine must be modified greatly to meet the demands for a successful commercial plane. He dwelt particularly on the point that travel by airplane would be safer, if indeed it is not already safer, than any mode of land travel. Thus, he said, we think nothing of trusting our lives to the thousand and one things necessary to carry a train at 60 miles per hr. Such travel is dependent upon many things. There are the engineers, firemen, towermen, switchmen, etc., the rails, ties, rail fastenings and hundreds of other things, the failure of any one of which spells disaster to a rapidly moving train. The slightest deviation of a train from its course often results in loss of many lives. In airplane handling we have no such conditions. There are no signals to watch and the successful handling of the machine in the air depends entirely on one man, and even this we may see automatically done in the near future in accordance with Mr. Kettering's talk.

There are two important factors in making the airplane safe as a commercial proposition. The two possible sources of danger, that is, the two likely to mean disaster, are structural breakage and fire. These, however, have been greatly reduced in machines of today, chiefly by careful design. In fact, structural breakdowns are rare nowadays and the fire menace has been overcome by placing the fuel tanks, exhaust pipes and line connections in such a way that leakage of fuel does not carry with it the element of danger as formerly.

High speeds are safer in aviation work than slower speeds, according to Mr. Stout. This is true because speed takes care of air turbulency and air pockets and the machine is handled more easily. An element of danger is always present in high landing speeds and, as low landing speeds are not generally found in machines capable of great flying speeds, this remains a problem for engineers to work out. A fast plane with low landing speed is the logical thing for commercial work, Mr. Stout said. Slow landing speed generally means that the plane must come down at a comparatively flat angle to the ground, which means the plane will probably roll a considerable distance. The three landing problems to be worked out take in slow landing, landing in a small space and landing on rough ground. Mr. Stout concluded his talk by outlining briefly the possibilities of establishing commercial air routes, showing that such means of transportation would not be hampered by conditions prevailing on land, such as track maintenance and similar things.

The officers of the Mid-West Section are G. W. Smith, chairman, Charles S. Whitney, vice-chairman, Darwin S. Hatch, secretary and L. R. Smith, treasurer.

Porter E. Stone was chairman of the General Committee under whose auspices the meeting was held. Other committees responsible for the success of the meeting were:

Program Committee—F. W. Parker, chairman, Porter E. Stone, and C. J. B. Lucas.

Dinner Committee—C. S. Whitney, C. S. Rieman, C. J. B. Lucas and B. B. Ayres.

Publicity Committee—C. S. Rieman, chairman, D. S. Hatch and C. J. B. Lucas.

Reception Committee—H. L. Horning, chairman, F. E. Place, James Viles, W. H. VanDervoort, C. H. John, C. S. Rieman, C. H. Roth, C. W. Stiger and E. H. Ehrman.

#### MOTOR TRUCK MEETING

The Motor Truck Meeting of the Society was held Monday evening, Feb. 10 at the Automobile Club of America, New York City. The meeting was preceded by a dinner, at which about 150 members and guests were present. Three papers relating to motor truck subjects were presented.

The first paper entitled "Truck Chassis Design," by C. T. Myers brought out the various essential points to be covered in the design and showed their influence on the life and operation of the trucks and also upon the consumption of fuel.

The next paper by B. B. Bachman was entitled "Pneumatic Tires for Trucks" and gave a comparison of the results obtained by the use of this form of tire as compared with the

solid type. The concluding paper entitled "Keeping 40,000 Army Trucks in Operation" was prepared by G. T. Randles, who was formerly director of the Maintenance Division of the Motor Transport Corps. It was presented by Capt. J. W. Lord who had been closely associated with the author in the activities of that division, and outlined not only the organization and the activities of the division but presented many interesting facts concerning its work.

#### TRACTOR AND AERONAUTIC MEETINGS

A meeting of the Society was held at Kansas City, Feb. 27 in connection with the Tractor Show. Edward R. Hewett's paper on the "Principles of the Wheeled Farm Tractor," which was presented at the Annual Meeting was discussed at the afternoon session, as well as Dr. Pogue's paper on "An Interpretation of the Fuel Problem." Other papers dealing with tractor testing and operation were presented. A dinner at the Hotel Baltimore in the evening completed the meeting. A full account of the discussion of the papers and the speeches will appear in the April issue of THE JOURNAL.

On March 7 an Aeronautic Meeting of the Society will be held in connection with the Aeronautic Exposition at Madison Square Garden, New York City, March 1 to 15. There will be an afternoon and an evening session with a supper in between. The speakers scheduled include men who have been prominent in Government and commercial aircraft work as well as Navy and Army officers who have served abroad. Papers on the design and performance of aircraft will be presented.

#### SECTION ACTIVITIES

The February meeting of the Buffalo Section which was scheduled for the 5th was canceled on account of the conflict in dates with the Annual Meeting of the Society. The lecture by G. Douglas Wardrop, managing editor, *Aerial Age Weekly*, which was to have been delivered at that meeting will be given at the meeting of the Section to be held on March 19. It is expected that a number of interesting facts about the part played by aircraft in the war will be brought out as well as their commercial use. President Manly will be present at the meeting, which will be preceded by a dinner.

The speaker at the February meeting of the Cleveland Section, which was held on the 21st, was David Beecroft, managing editor, *Class Journal Publishing Co.* At this meeting, which was held in connection with the Cleveland Automobile Show, the part played by the motor truck in the war was featured.

Edward A. Huene, Los Angeles, Cal., presented a paper on "The Direct Self-Feeding Carbureter" at the February meeting of the Mid-West Section. This was held in the rooms of the Western Society of Engineers, Chicago, Ill., Feb. 14.

At the meeting of the Minneapolis Section, which was held on Feb. 5, the principal paper was presented by George W. Hoyt, chief engineer, the Oakes Co., Indianapolis, Ind., who spoke on "Radiator Cooling Fans." The other paper, entitled "Repair Engineering," was presented by D. W. Onan, chairman of the Repair Engineering Committee of the Section. The subject for the meeting to be held on March 5 is "Implements Designed for Tractor Belt Power and Their Characteristics" and a paper will be presented by F. N. G. Kranich, agricultural engineer, Hyatt Roller Bearing Co. J. B. Mooney, Auto Engine Works, St. Paul, Minn., will also present a paper on "Cylinder and Piston Refitting."

David Beecroft, managing editor, *Class Journal Publishing Co.*, will be the speaker at the March meeting of the Mid-West Section to be held at Chicago on the 7th. His address will deal with the trip which he recently made to the war zone. At the meeting on April 11, Professor Neis will present his paper on "The Possibilities of Steam Power," which is printed elsewhere in this issue of THE JOURNAL. Other papers will be presented by Frank Jay and Mr. Dake, chief engineer of the Pyle-National Co. The speaker at the meeting of May 9 will be William B. Stout, United Aircraft Engineering Corporation, who will read a paper dealing with new developments in aircraft.

## PERSONAL NOTES OF THE MEMBERS

F. Ackerman, works manager, Curtis & Co. Mfg. Co., St. Louis, Mo., has been appointed vice-president and works manager.

Arthur H. D. Atree, who was general sales manager and assistant treasurer of the Bosch Magneto Co., has been elected vice-president of the American Bosch Magneto Corporation.

Stedman Bent, president of the Automobile Club of Philadelphia, has been appointed chairman of the motor truck board of the American Automobile Association. The board will have to do with motor truck operation and will include men from all sections of the country. C. A. Musselman is the representative of the Philadelphia Section of the board.

M. H. Blank has received an honorable discharge from the army and has been appointed automotive engineer of the Lynite laboratories of the Aluminum Castings Co., Cleveland, Ohio. Before entering the army he was assistant engineer of the Premier Motor Car Corporation.

John T. Boone has resigned as president of Allen & Boone, Inc., consulting engineers, and has opened an office at Detroit, Mich., where he will specialize in automotive design and consulting work.

William M. Britton has resigned from the Government service and has entered the employ of the Kelly-Springfield Tire Co., Akron, Ohio, in the office of the manufacturing manager.

R. Chauveau, formerly aeronautical mechanical engineer, with the Bureau of Aircraft Production, Washington, has been appointed engineering manager of the Ericsson Mfg. Co., Buffalo, N. Y.

A. R. Clas has disposed of his interest in the Falls Motors Corporation, Sheboygan Falls, Wis., and purchased a controlling interest in the Lewis Steel Products Co., Cleveland, Ohio.

Emory F. Creager, formerly assistant factory manager of the Remy Electric Division of the United Motors Corporation, Anderson, Ind., has been assigned to temporary duty by the Government in the engineering department of the Springfield Aircraft Corporation, Springfield, Mass.

V. W. Dow, who was formerly sales manager for the American Bronze Corporation, has been appointed New England representative of the corporation, with offices at 348 Tremont Building, Boston, Mass.

S. F. Dupree, formerly vice-president and sales manager, Caskey-Dupree Mfg. Co., Marietta, Ohio, has been appointed vice-president of the Automotive Products Co., Detroit, Mich.

Stephen A. Ellett, formerly with the Eclipse Machine Co., Elmira, N. Y., as assistant engineer, has resigned and is now associated with Frederick S. Ellett, consulting engineer, of that city.

Don M. Ferguson has been appointed resident engineer of the Michigan District, Ordnance Department, with offices in the Book Building, Detroit, Mich.

Charles Freosch has resigned as aeronautical mechanical engineer for the Government and is now designing engineer for the Fergus Motors of America, Newark, N. J.

A. H. Gfrorer has been honorably discharged from the Army with the rank of first lieutenant. He has ac-

cepted a position as industrial truck engineer with the Lakewood Engineering Co., Cleveland, Ohio.

C. S. Gmeiner, who has had his name changed by the Michigan courts to C. G. Minor, has been appointed assistant manager of the experimental laboratory of the Militor Corporation, Jersey City, N. J. He was formerly connected with the States Motor Car Co., Kalamazoo, Mich.

Major James Guthrie has been transferred from the carriage bureau, engineering division, Ordnance Department, Washington, and been appointed engineering manager for the Michigan District, Ordnance Department, with offices in the Book Building, Detroit, Mich.

Major B. Hawxhurst, formerly Detroit district manager of the Westinghouse Electric & Mfg. Co., has been elected president and general manager of the Automotive Products Co., Kresge Building, Detroit, Mich.

M. Lair Hull, who has been serving in the production division of the Ordnance Department, has been discharged from the Army and has resumed his duties as vice-president of the Rex Mfg. Co., Connersville, Ind.

M. R. Hutchinson, formerly engineering advisor to Thomas A. Edison, Orange, N. J., has been appointed president of Miller Reese Hutchinson, Inc., with offices in the Woolworth Building, New York City.

Edwin H. Kottbauer, who was inspector of ordnance at the plant of the Cotta Transmission Co., Rockford, Ill., has entered the employ of the Wisconsin Mfg. Co., Milwaukee, Wis.

Joseph Leopold has resigned his commission as lieutenant in the Air Service, U. S. A., and accepted the position of mechanical engineer and sales manager with the Jones-Motrola, Inc., New York City. Prior to the war Mr. Leopold was the chief engineer of the Walker M. Levett Co., New York City.

Capt. Julius M. Lonn has resumed charge of the engineering work of the Great Western Mfg. Co., LaPorte, Ind. For the past twenty months he has been located in the small arms ammunition department, Frankford Arsenal, Philadelphia, Pa., and has recently been released from military service.

R. D. Madison has resigned as chief draftsman in the motor equipment section, Ordnance Department, and has accepted a position with the Buffalo Forge Co., Buffalo, N. Y.

Howard Marmon, who was formerly associated with the experimental engineering division, Air Service at McCook Field, Dayton, Ohio, has returned to Indianapolis and resumed his duties with the Nordyke & Marmon Co.

Wallace T. Miller has resigned as Western sales manager of the King Motor Car Co., Detroit, Mich., and gone to St. Louis, Mo.

M. B. Morgam, who formerly held the rank of major in the engineering division, motor equipment section, Ordnance Department, has been appointed chief engineer of the Cleveland Tractor Co., Cleveland, Ohio.

E. C. Morse, who was formerly the Washington representative of the Willys-Overland Co., has been transferred to its New York City office.

A. T. Murray, president of the Bethlehem Motors Corporation, Allentown, Pa., has been elected president and

## PERSONAL NOTES OF THE MEMBERS

209

a director of the American Bosch Magneto Corporation, which has purchased the entire property holdings, assets and patent rights of the Bosch Magneto Co. In addition to managing the affairs of the Magneto corporation he will continue as the active head of the Bethlehem Motors Corporation.

Berne Nadall, who resigned as sales engineer of the Stewart-Warner Speedometer Corporation after a period of seven years to enter the Government service, has severed his connection with the Government and is now at his home at Paoli, Ind., where he expects to spend the greater part of the year.

A. L. Nelson has been appointed chief engineer of the Premier Motor Corporation, Indianapolis, Ind. He was formerly consulting engineer of armament in the airplane engineering department, Bureau of Aircraft Production, and was stationed at McCook Field, Dayton, Ohio.

H. H. Newsom has been appointed general manager of the Standard Welding plant of the Standard Parts Co., Cleveland, Ohio. He was formerly director of purchases with this company.

W. T. Norton, Jr., who was formerly in charge of the executive branch, engineering division, Motor Transport Corps, has been appointed chief engineer of the Russel Motor Axle Co., North Detroit, Mich.

W. J. Pearmain has returned from fourteen months' service with the American Expeditionary Forces, and is now at his home in Racine, Wis.

C. D. Proctor, who was a student at the Ordnance Engineering School, Aberdeen Proving Grounds, Aberdeen, Md., has been discharged from active service and has taken a position with the Northern Motors & Mfg. Co., Detroit, Mich.

L. P. Prossen has resigned as mechanical superintendent of the Black & White Taxicab Co., New York City, and has been elected vice-president of the Nilson-Miller Co., Hoboken, N. J. He will have charge of the gear cutting, piston and piston ring departments.

E. H. Ruck has resigned as chief engineer of the Cleveland Tractor Co. to become chief engineer of the Automotive Corporation, Fort Wayne, Ind.

Dempster M. Smith, who was formerly associated with Brock & Smith, patent experts, Washington, D. C., has opened an office in New York City as patent attorney and mechanical expert.

Edson H. Smith, assistant naval inspector of ordnance at the plant of the American & British Mfg. Co., Bridgeport, Conn., has been promoted from ensign to lieutenant, junior grade, in the U. S. Naval Reserve Force.

F. W. Sutton has been appointed chief engineer for the Charles E. Bedaux Co., industrial engineers, Cleve-

land, Ohio. He resigned as general superintendent of the Dayton Wright Airplane Co., Dayton, Ohio, to accept the new position in Cleveland, and prior to that was production manager of the Continental Motors Corporation.

Sutherland G. Taylor, Jr., has been appointed export manager of the Holt Mfg. Co. He was recently discharged from the Army, where he served as assistant to the chief of the motor equipment section, procurement division, Ordnance Department, with rank of lieutenant. Mr. Taylor was president and New York manager of Cyrus Robinson & Co., engineers and exporters, New York City and London, for several years prior to joining the army.

R. B. Templeman has severed his connection with the Motor Transport Corps and returned to the Jordan Motor Car Co., Cleveland, Ohio, where he was employed prior to entering the service of the Government.

Fred I. Tone, formerly aeronautical mechanical engineer, research department, Bureau of Aircraft Production, stationed at Dayton, Ohio, has accepted a position with the U. S. Ball Bearing Mfg. Co. Chicago, Ill.

P. G. Van de Velde, who has been associated with the French High Commission in New York City, has returned to France.

Henry A. Wagner, formerly special representative of the White Co., Cleveland, Ohio, has been appointed chief engineer and production manager of the Famous Trucks, Inc., Saint Joseph, Mich.

John M. Walter has resigned as mechanical draftsman with the Bureau of Ordnance, Navy Department, Washington, D. C., and is now at his home in Cincinnati, Ohio.

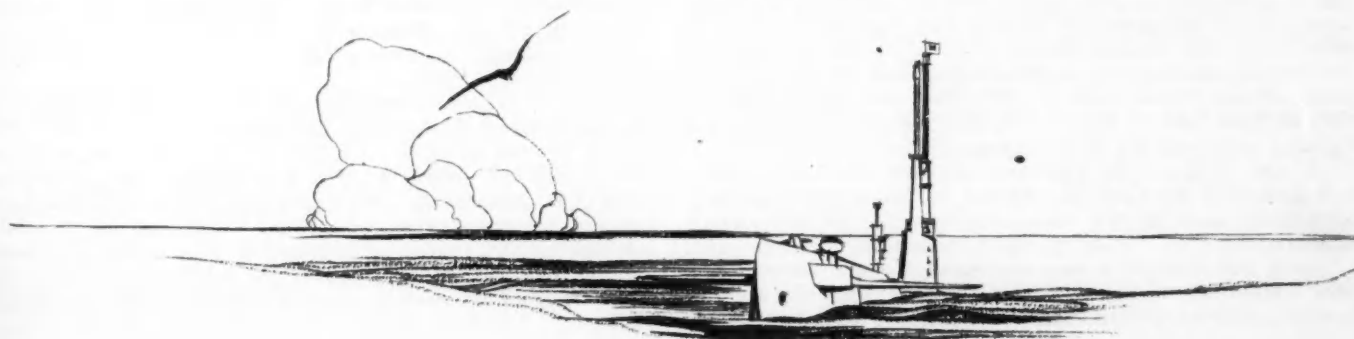
Henry E. Weber has resigned as tool design checker with the Nordyke & Marmon Co., Indianapolis, Ind., to accept a position as layout man on engines and bodies with the National Motor Car & Vehicle Corporation of that city.

S. T. Webster, who formerly practiced electrical and mechanical engineering in St. Louis, Mo., has associated himself with C. H. Wolfe, to form the W. & W. Engineering Co., Detroit, Mich.

Erwin A. Weiss, who has been an automobile engineer in the engineering bureau, motor section, Ordnance Department, has been discharged from the Army and has accepted the position of automotive engineer with the Service Motor Truck Co., Wabash, Ind.

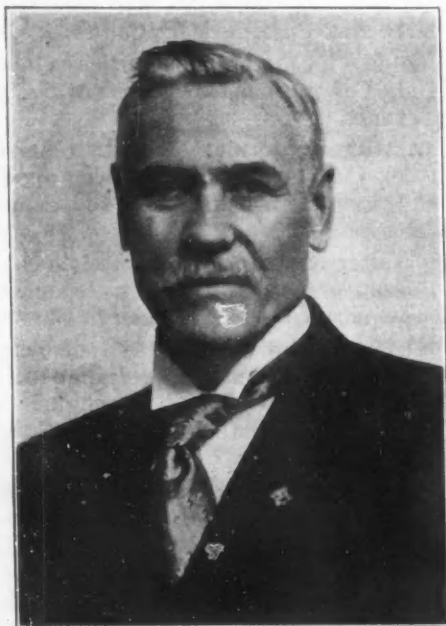
Herbert J. Woodall has been discharged from the Navy and has become a member of the M. & W. Tire Co., Detroit, Mich.

J. G. Zimmerman has been appointed engineer in charge of the ignition development work of the Jefferson Electric Mfg. Co., Chicago, Ill. He was formerly associated with the technical publicity department of the Splittorf Electrical Co., Newark, N. J.



## OBITUARIES

ROLLA C. CARPENTER, who was probably best known as professor emeritus of experimental engineering in Cornell University, died Jan. 19 at his home, Ithaca, N. Y. He was born near Orion, Mich., June 26, 1852, and was graduated from the Michigan Agricultural College in 1873. In 1875 he received the degree of civil engineer from the University of Michigan, and was then engaged as instructor in the Michigan Agricultural College. At this time he did graduate work and received the degree of Master of Science in 1876. He was elected professor of mathematics and civil engineering at the Michigan Agricultural College in 1878 and remained there twelve years. For part of this period he spent his vacation, which came in the winter months, studying at other institutions, including the Massachusetts Institute of Technology and Cornell University, where he received the degree of Master of Mechanical Engineering in



ROLLA C. CARPENTER

1888. His connection with the Lansing Iron & Engine Co., Lansing, Mich., as consulting engineer assisted him in the preparation of his thesis for this degree. In 1890 he was elected associate professor of engineering at Cornell University and the laboratory work was organized as a separate department under his direction. Five years later he was elected professor of experimental engineering, occupying the chair until 1917 when he was made professor emeritus.

Professor Carpenter engaged in a diversified field of investigation and research, the work covering problems relating to powerplants, gas engines, cement and coke manufacture, railway management, heating and ventilating, etc. He was one of the leading patent experts in the country and was employed by many of the leading law firms in various parts of the United States. He acted as engineer for the City of New York on high-pressure pumping engines and the lighting and heating of municipal buildings from 1913 to 1916, and designed the high-pressure fire protection system installed at Baltimore. A number of pieces of laboratory apparatus, such as the Carpenter coal calorimeter, which was the standard for many years to test the heating value of coal, the throttling and separating steam calorimeters now extensively used, a friction testing machine and an inertia governor for the steam engine, are some of his in-

ventions. He was honored by appointment to various positions of distinction, including that of judge of machinery and transportation at the Chicago Exposition in 1893, the Buffalo Exposition in 1901 and the Jamestown Exposition in 1907. In 1915 he was a member of a commission appointed by the Academy of Science at the request of the President of the United States to investigate the slides at the Panama Canal and to make such recommendations as in the judgment of the commission would improve the conditions and lessen the possibility of slides in the future.

All of the leading engineering societies of America had the name of R. C. Carpenter on their membership rolls. He was elected a Member of the Society in 1908 and served as vice-president from 1910 to 1912. He was vice-president of the American Society of Mechanical Engineers from 1908 to 1911 and served on various committees, the most important one probably being the Boiler Code Committee. Professor Carpenter was a charter member of the American Society of Heating and Ventilating Engineers and was elected president in 1898. In his term of office he did much to increase the prestige of that organization as a national technical society.

He was also a member of the American Society of Civil Engineers, the American Institute of Mining Engineers and the American Society of Refrigerating Engineers. A number of works on engineering and the gas engine are from his pen. The best one of these is his book entitled "Heating and Ventilating Buildings," which was published in 1895 and has been revised six times, much original material from the author's own experience being incorporated.

HOWARD E. OBERLY died of pneumonia Nov. 1, 1918, aged 31 years. He was born at Milwaukee, Wis., Sept. 30, 1887, and after spending one year at the University of Wisconsin entered the employ of the Chicago, Milwaukee & St. Paul Railroad in 1904. He remained in the Milwaukee shops of the railroad in the pattern department, foundry and drawing office for five years and left to become a traveling sales representative for the Oster Mfg. Co., Cleveland, Ohio. In 1911 he entered the employ of Joseph T. Ryerson & Son, Chicago, Ill. His duties there consisted of developing patents and representing the firm among automobile and gas engine manufacturers. In 1914 he was appointed superintendent of the bearings department, a position which he held at the time of his death. Mr. Oberly was elected to Associate Member grade in the Society in 1914.

CAPT. HARRY COLBURN TURNER died of jaundice in the hospital in Abbeville, France, on Dec. 6. He was born in 1873 in Maine. In 1897 he took his degree as A.B. in chemistry at the Leland Stanford Jr. University. He engaged at once with the Val Verde Mining & Milling Co., Randsburg, Cal., and went into mechanical and reconstruction engineering. Here and with the St. Elmo Mining & Water Co. of the same town his work was technical in character. In 1899 he founded the Turner Oil Co., Los Angeles, Cal., becoming vice-president and field manager. Here he installed air lift water-pumping machinery and compiled much needed data on its efficiency. During this time he also acted as superintendent of drilling and machinery installation at Whitten and Fillmore, Cal. From 1903 to 1906 he was president and general manager of the California Concrete Building Block Co., Los Angeles, Cal.

His work in the automobile field began with the founding of the Southern California Automobile Club, in 1900. He was a charter member and treasurer of this organization and owned and drove the first automobile making the trip from Los Angeles to San Francisco. His interest once aroused, he began work on problems which are still of prime interest in the industry, lubricating oils, shock absorbers and springs, patenting his creative work in the latter in 1915. Capt. Turner was elected a Member of the Society in 1915.

## APPLICANTS FOR MEMBERSHIP

211

# Applicants for Membership

The applications for membership received between Jan. 20 and Feb. 20, 1919, are given below. The members of the Society are urged to send any pertinent information with regard to those listed which the Council should have for consideration prior to their election. It is requested that such communications from members be sent promptly.

ACKERLIND, D. M., chief draftsman, tractor department, Velie Motors Corporation, *Moline, Ill.*  
 ACKERMAN, ALBERT H., member of firm, Carlson & Ackerman, *Washington.*  
 ANDREWS, EDWARD F., president, Universal Engineering Co., *Maywood, Ill.*  
 ANNIS, EMMETT F., mechanical engineer, Inspection Division, Motor and Carriage Section, Ordnance Department, *Detroit, Mich.*  
 ARMITAGE, JOSEPH B., mechanical engineer, research laboratories, Aluminum Castings Co., *Cleveland, Ohio.*  
 AYERS, J. G., JR., chief metallurgist, Hyatt Roller Bearing Division, General Motors Corporation, *Newark, N. J.*  
 BALDWIN, CURTIS C., general manager, Baldwin Mfg. Co., *Sparta, Mich.*  
 BANE, COL. THURMAN H., Air Service, McCook Field, *Dayton, Ohio.*  
 BELL, W. A., sales manager, C. M. Hall Lamp Co., *Kenosha, Wis.*  
 BLANKMAN, LYNN V., assistant quality manager, Wright-Martin Aircraft Corporation, *New Brunswick, N. J.*  
 BURROWS, CHARLES W., consulting engineer, *Grasmere, Borough of Richmond, New York City.*  
 CAMPBELL, ROBERT H., inspector, Motor Transport Corps, Locomobile Co., *Bridgeport, Conn.*  
 CAREY, P. H., commercial engineer, Sprague Electric Works, *Detroit, Mich.*  
 CASHION, A. T., head of shipping and production work, Standard Aircraft Corporation, *Elizabeth, N. J.*  
 CETRULE, JOHN, tool and gage inspector and instructor in technical mathematics, Wright-Martin Aircraft Corporation, *Long Island City, N. Y.*  
 CHURCH, CAPT. E. SOUTHWORTH, Vehicle Division, Ordnance Department, Munitions Building, *Washington.*  
 CLERKE, JOHN W., advisory engineer, R. L. Smith Shipping Co., *New York City.*  
 CLEVELAND, W. B., superintendent aeronautical supplies, Aviation Department, Imperial Munition Board, *Toronto, Canada.*  
 COLE, CYRUS L., sales engineer and manager, Wisconsin Motor Mfg. Co., *Milwaukee, Wis.*  
 CONNELL, W. J., president, W. J. Connell Co., *Boston, Mass.*  
 CROUCH, GEORGE F., technical editor, Motor Boat Publishing Co., *New York City.*  
 DAVIS, CHARLES H., assistant to general manager, Double Seal Ring Co., *Chicago, Ill.*  
 DECHARD, ALBERT W., draftsman, Wright-Martin Aircraft Corporation, *New Brunswick, N. J.*  
 EIDMAN, ENSIGN FRANK L., engineer officer, U. S. Naval Aviation, *North Bergen, N. J.*  
 FOX, JOHN C., tool designer, Standard Aircraft Corporation, *Elizabeth, N. J.*  
 FRANCIS, PAUL HART, material testing engineer and inspector, Springfield Aircraft Corporation, *Springfield, Mass.*  
 GERHARDT, ENSIGN CHARLES L., main garage, U. S. Naval Training Station, *Great Lakes, Ill.*  
 GEYER, HARVEY D., superintendent, plant No. 3, Dayton Wright Airplane Co., *Dayton, Ohio.*  
 GOTTSCHALK, LIEUT. PROSPER L., Motor Division, Quartermaster Corps, inspector in charge at Sterling Motor Truck Co., *Milwaukee, Wis.*  
 GRIMMELSMAN, F. F., general manager, Perfection Spring Plant, Standard Parts Co., *Cleveland, Ohio.*  
 HARKLESS, M. J., engineer, railroad department, Buda Co., *Harvey, Ill.*  
 JAMIESON, JOHN STEWART, outside production, Standard Aircraft Corporation, *Elizabeth, N. J.*  
 JENSEN, GEORGE C., designing, Boericke & Runyon Co., *New York City.*  
 JUDSON, DWIGHT R., department manager, Talcott Co., *Hartford, Conn.*  
 KELLER, GROVER E., tool designer, Holt Mfg. Co., *Stockton, Cal.*  
 KEPERLEY, JAMES E., vice-president and general manager, Curtiss Aeroplane & Motor Corporation, *Buffalo, N. Y.*

KERN, DAVID R., instrument inspector, Bureau of Aircraft Production, *Buffalo, N. Y.*  
 KNOWLES, EDWIN B., general sales manager, Thermoid Rubber Co., *Trenton, N. J.*  
 KRAUSS, JOHN S., treasurer, L. H. Gilmer Co., *Tacony, Philadelphia, Pa.*  
 KUBLIN, GEORGE H., engineer, Moon Motor Car Co., *St. Louis, Mo.*  
 LACK, FRED. S., secretary, treasurer and general manager, Lack Mfg. Co., *Paducah, Ky.*  
 LANG, CURRIER, assistant general manager, Detroit Gear & Machine Co., *Detroit, Mich.*  
 LANG, MARTIN H., owner and manager, Progressive Machine & Model Works, *Minneapolis, Minn.*  
 LEUTWILER, O. A., professor of machine design, University of Illinois, *Urbana, Ill.*  
 LIGGETT, JOHN THOMAS, assistant engineer, Iowa Cord Tire Co., *Des Moines, Iowa.*  
 LITTLE, THOMAS J., JR., engineer, Lincoln Motor Co., *Detroit, Mich.*  
 MCCARTHY, J. B., engineer, National Metal Molding Co., *Pittsburgh, Pa.*  
 MCCARTHY, MAURICE F., superintendent of engine inspection, Curtiss Aeroplane & Motor Corporation, *Hammondsport, N. Y.*  
 MACDONALD, H. P., vice-president, Snead & Co. Iron Works, *Jersey City, N. J.*  
 MACEWAN, THOMAS S., sales engineer, New Departure Mfg. Co., *Bristol, Conn.*  
 MACGREGOR, JAMES S., material engineer, United Aircraft Engineering Corporation, *New York City.*  
 MANNING, J. R., secretary and sales manager, Coleman Tractor Corporation, *Kansas City, Mo.*  
 MATTHEWS, JOSEPH L., superintendent, International Motor Co., *Plainfield, N. J.*  
 NELLIS, CARL P., superintendent, Dayton Wright Airplane Co., *Dayton, Ohio.*  
 NISHIOKA, TOSHIO, resident engineer, Shibaura Engineering Works, c/o General Electric Co., *Schenectady, N. Y.*  
 NORTON, ENSIGN JOSEPH M., U. S. Navy Yard, *Brooklyn, N. Y.*  
 NUTT, HAROLD, assistant chief engineer, gas engine department, B. F. Sturtevant Co., *Hyde Park, Boston, Mass.*  
 PADGETT, JOSEPH EDWARD, assistant to research and experimental engineer, Nordyke & Marmon Co., *Indianapolis, Ind.*  
 PARADISE, L. A., assistant superintendent, Waterloo Gasoline Engine Co., *Waterloo, Iowa.*  
 PETER, R. J., chief chemist, Warner Gear Co., *Muncie, Ind.*  
 PURCHASE, FIRST-LIEUT. EDWIN K., Truck Section, Motors Division, *Washington.*  
 RENOLD, CHARLES G., managing director, Hans Renold, Ltd., Burnage Works, *Heaton Mersy, Manchester, England.*  
 ROBERTS, H. E., draftsman, Studebaker Corporation, *Detroit, Mich.*  
 ROOT, H. M., treasurer, Curtiss Aeroplane & Motor Corporation, *Buffalo, N. Y.*  
 ROWE, JOE S., draftsman, Holt Mfg. Co., *Stockton, Cal.*  
 SHIELDROCK, FIRST-LIEUT. L. SPENCE, Tank, Tractor and Trailer Division, Engineering Section, Ordnance Department, *Detroit, Mich.*  
 SHILLING, FIRST-LIEUT. DAVID, 104th Ammunition Train, A. E. F., *France.*  
 SINCLAIR, JAMES GLEN, chief engineer, Illinois Tractor Co., *Bloomington, Ill.*  
 SMITH, SERGEANT CHARLES FREDERICK, inspector, Motor Transport Corps, Camp Holabird, *Baltimore, Md.*  
 SMITH, GEORGE M., treasurer, Hill-Smith Metal Goods Co., *Boston, Mass.*  
 STEINMAN, D. B., professor in charge of civil and mechanical engineering, College of the City of New York, *New York City.*  
 STERN, ALLAN G., assistant physicist, Bureau of Standards, *Washington.*  
 STRYKER, CARLETON E., U. S. N. R. F., Pelham Bay Park Training Camp, *Pelham, N. Y.*  
 TANN, WALTER L., truck layout man, Watson Wagon Co., *Canastota, N. Y.*  
 TITCHENER, F. L., vice-president, Brewer Titchener Corporation, *Cortland, N. Y.*  
 TORNEY, HENRY W., vice-president, Thomson-Torney Engineering Corporation, 51 East Forty-second Street, *New York City.*  
 TRUMBAUER, L. S., assistant chief draftsman, Vim Motor Truck Co., *Philadelphia, Pa.*  
 VACHON, L. W., drawing checker, Holt Mfg. Co., *Stockton, Cal.*  
 VAN SCOYOC, A. J., factory manager, Kokomo Rubber Co., *Kokomo, Ind.*  
 VER PLANCK, W. EVERETT, turbine engineering department, General Electric Co., *Schenectady, N. Y.*  
 WATANABE, SABRO, managing director, Japan Special Steel Co., *Tokyo, Japan.*  
 WEISKE, EDGAR F., mechanical draftsman, Holt Mfg. Co., *Stockton, Cal.*  
 WELLES, HALSEY V., sales engineer, Detroit Gear & Machine Co., *Detroit, Mich.*  
 WHITTINGTON, FREDERICK G., chief engineer, Stewart-Warner Speedometer Corporation, *Chicago, Ill.*  
 YOCOM, ARTHUR H., designing, supervising and efficiency engineering, Wright-Martin Aircraft Corporation, *Long Island City, N. Y.*  
 YOSHIMI, SEIICHI, chief engineer, Nakamura & Co., *Tokyo, Japan.*

# Applicants Qualified

The following applicants have qualified for admission to the Society between Jan. 16 and Feb. 15, 1919. The various grades of membership are indicated by (M) Member; (A) Associate Member; (J) Junior; (Aff.) Affiliate; (Aff. Rep.) Affiliate Representative; (S. E.) Student Enrollment.

- BARTON, FRED C. (M.) application engineer, Bijur Motor Appliance Co., Hoboken, N. J.
- BATES, ALBERT H. (M.) chief engineer, Emerson-Brantingham Co., 2723 University Avenue, S. E., Minneapolis, Minn.
- BEESE, ARTHUR J. (A) president, Saginaw Sheet Metal Works, Saginaw, Mich.
- BOEHME, PAUL L. (A) production clerk, Ordnance Department, Holt Mfg. Co., Peoria, Ill. (mail) 211 New York Avenue.
- BOND, CLARENCE R. (J) assistant engineer, Arvac Mfg. Co., Anderson, Ind.
- BOULCOTT, WILLIAM CHARLES (A) sales engineer, Dayton Engineering Laboratories Co., Dayton, Ohio.
- CATO, JOSEPH L. (M) aeronautical experimental engineer, Marlin-Rockwell Corporation, Liberty Field, New Haven, Conn.
- CAWTHRA, ERNEST H. (M) production engineer, Curtiss Aeroplane & Motor Corporation, 2000 Elmwood Avenue, Buffalo, N. Y. (mail) 86 Bedford Avenue.
- CROFOOT, CHARLES E. (M) president, treasurer, general manager and engineer, Crofoot Gear Works, Inc., 31 Ames Street, Cambridge A. Boston, Mass.
- DAVISON, G. C. (M) vice-president, New London Ship & Engine Co.; director, National Tractor Co., Groton, Conn.
- DAY, W. E., JR. (A) erecting superintendent, International Motor Co., Plainfield, N. J. (mail) 5 Rockview Avenue.
- DURKEE, CHARLES D. (A) president, Charles D. Durkee & Co., Inc., 2 and 3 South Street, New York City.
- ENGEL, FIRST-LIEUT. PAUL H. (A) engineer, Ordnance Department, Washington, (mail) 12 Landscape Avenue, Yonkers, N. Y.
- EVERSON, J. A. (A) tractor sales manager, International Harvester Co. of America, Chicago, Ill. (mail) 4639 Beacon Street.
- EWELL, ROBERT G. (A) sales and advertising manager, Allen Motor Co., Fostoria, Ohio, (mail) 693 Columbus Avenue.
- FALES, DEAN ABNER (M) instructor, Massachusetts Institute of Technology, Cambridge, Mass., (mail) 145 Highland Street, West Newton, Mass.
- FARNSWORTH, THOMAS WEBSTER (A) mechanical engineer, American Committee for Relief and Reconstruction in the near East, Turkey, (mail) 346 Fairfield Avenue, Hartford, Conn.
- FRANK, EDWARD D. (M) sales manager, National Automatic Tool Co., Richmond, Ind., (mail) 1120 Main Street.
- FUJIWARE, TOSHIO (A) managing director, Naigai Kogyo Kaisha, Ltd. (International Industrial Co., Ltd.), 5 Yarakuchō, I-chomei, Kojimachi-Ku, Tokyo, Japan.
- GRUBB, JOSEPH K. (M) 230 East North Street, Indianapolis, Ind.
- HAMILTON, DOUGLAS T. (A) advertising manager, Fellows Gear Shaper Co., Springfield, Vt., (mail) 45 Woolson Ave.
- HOLLAND, WALTER E. (M) research engineer, Philadelphia Storage Battery Co., Ontario and C streets, Philadelphia, Pa.
- HORN, HAROLD J. (M) electrical engineer and superintendent, John A. Roebling's Sons Co., 318 South Broad Street, Trenton, N. J., (mail) 318 Chestnut Avenue.
- HUSTED, DONALD R. (J) aeronautical engineer, Curtiss Engineering Corporation, Garden City, N. Y.
- JORDAN, RICHARD MICHAEL (A) superintendent, aircraft production, Champion Ignition Co., Flint, Mich.
- KING, FRANK (M) process engineer, Wright-Martin Aircraft Corporation, New Brunswick, N. J. (mail) 31 South Fourth Avenue, Highland Park, N. J.
- KOYA, HISASHI (M) aeronautical engineer, Imperial Japanese Navy, Room 212, 1 Madison Avenue, New York City.
- KREUSSER, O. T. (A) ignition engineer, Dayton Engineering Laboratories Co., Dayton, Ohio.
- LANE, GUY S. (A) manager, Westinghouse Air Spring Co., 1428 Vine Street, Philadelphia, Pa.
- LARSON, ARVID G. (A) superintendent, Dodge Tool Co., Grinnell, Iowa, (mail) Brande Apartments.
- LAY, WALTER EDWIN (M) instructor in automotive engineering, University of Michigan, Department of Mechanical Engineering, Ann Arbor, Mich. (mail) 1125 Forest Avenue.
- LYMAN, W. H. (M) general superintendent, Warner Gear Co., Muncie, Ind. (mail) 911 University Avenue.
- LYON, A. H. (M) chief tool and equipment designer, Ingersoll Milling Machine Co., Rockford, Ill. (mail) 1735 Camp Avenue.
- MC CONIGHEN, WILLIAM H. (A) foreman, Kissel Motor Car Co., Hartford, Wis. (mail) 254 Teddy Avenue.
- MOBLEY, CLAUDE S. (J) automotive engineer, Service Motor Truck Co., Wabash, Ind.
- MORRILL, LEWIS H. (M) assistant chief engineer, Buda Co., Harvey Ill.
- NORTHROP, L. M. (A) sales engineer, Joseph T. Ryerson & Son, Sixteenth and Rockwell streets, Chicago, Ill. (mail) 6153 St. Lawrence, Avenue.
- PATCHELL, FREDERICK J. (A) manager truck and automobile department, Federal Export Corporation, 42 Broadway, New York City. (mail) Columbia University Club, 4 West Forty-third Street.
- PAULSEN, CARLEY (A) inspector of engineering material, Curtiss Aeroplane & Motor Corporation, Hammondsport, N. Y. (mail) 228 Mount Hope Place, New York City.
- PIERSON, TORVALD N. (J) designer, Oneida Motor Truck Co., Green Bay, Wis.
- POPP, HAROLD M. (A) director of purchases, Curtiss Aeroplane & Motor Corporation, Hammondsport, N. Y. (mail) Lock Box 163.
- POYNOR, FREDERICK W. (M) chief engineer, R. Martens & Co., Ltd., 149 Leadenhall Street, E. C. 3, London, England.
- RAND, LARS (M) assistant engineer, Wilcox-Bennett Carburetor Co., 1030 Marshall Street, N. E., Minneapolis, Minn. (mail) 3020 Portland Avenue.
- RATHERT, GEORGE AUGUST (J) assistant chief draftsman, U. S. Naval Aircraft Factory, Navy Yard, Philadelphia, Pa.
- REID, JOSIAH E. (M) designing engineer, International Motor Co., Sixty-fourth Street and West End Avenue, New York City. (mail) 3311 Broadway.
- RENDALL, HAROLD G. (A) draftsman, Mitchell Motors Co., Inc., Racine, Wis. (mail) 1436 Quincy Avenue.
- ROBISON, HENRY L. (J) tool designer, Domestic Engineering Co., Dayton, Ohio. (mail) 334 Park Street.
- ROE, HARRY R. (J) draftsman, Hupp Motor Car Corporation, Detroit, Mich. (mail) 1254 Sixteenth Street.
- RUSK, EDWARD I. (M) engineer, R. M. Owen & Co., 1 West 142nd Street, New York City.
- SCHROEDER, WILLIAM (M) assistant chief draftsman, Engineering Division, Motor Transport Corps, Washington (mail) 312 Lincoln Road, Brooklyn, N. Y.
- SEAMAN, COL. A. OWEN (M) General Staff Corps, Washington. (mail) 1801 K Street, N. W.
- SLAGHT, W. WHITNEY (J) experimental engineer, Pierce-Arrow Motor Car Co., Elmwood Avenue, Buffalo, N. Y.
- SMITH, R. LEON (J) designer, Airplane Engineering Division, McCook Field, Dayton, Ohio. (mail) P. O. Box 73.
- TAYLOR, LIEUT. CHARLES F. (J) U. S. N. R. F., Aeronautical Engine Laboratory, U. S. Navy Yard, Washington.
- TURNBULL, WILLIAM (M) chief engineer, Holt Mfg. Co., East Peoria, Ill.
- TURNER, J. E. (A) manager, Bernhard & Turner Auto Co., Des Moines, Iowa. (mail) 1122 Thirty-eighth Street.
- TYNAN, WILLIAM J. (M) engineer, general inspection supervisor, Standard Aircraft Corporation, Elizabeth, N. J. (mail) 78 Court Street, Newark, N. J.
- WACKER, HERBERT (J) foreman, Caproni drafting room, airplane division, Fisher Body Corporation, Detroit, Mich. (mail) 329 Montclair Avenue.
- WARNER, CHARLES F. (A) engineer, Fairbanks, Morse & Co., Sheffield Plant, Three Rivers, Mich. (mail) 701 Portage Avenue.
- WATERMAN, ROYAL SUTHERLAND (A) service manager, F. E. Stuyvesant Motor Co., 2010 Euclid Avenue, Cleveland, Ohio.
- WEBER, WALTER H. (A) research engineer, supervisor of tests and chemist, Zenith Carburetor Co., Hart Avenue, Detroit, Mich. (mail) 1702 Waterloo Street.
- WHITE, JOSEPH L. (J) outside tester, Robert S. Taylor, Seattle, Wash. (mail) 405 East Pine Street.
- WILDHACK, GEORGE O. (A) proprietor and manager, Wildhack Co., 927 North Meridian Street, Indianapolis, Ind. (mail) 324 East Thirty-sixth Street.
- WILSON, MARK LEONARD (J) draftsman, engineering department, White Motor Co., East Seventy-ninth Street, Cleveland, Ohio.
- WING, RAYMOND N. (M) aeronautical engineer, Curtiss Aeroplane & Motor Corporation, Buffalo, N. Y. (mail) 100 Robie Avenue.
- WINTER, GEORGE WILLIAM (J) foreman, Ottenjohn Auto Repair Co., 3439 Michigan Avenue, Hyde Park, Cincinnati, Ohio. (mail) cor. Gilbert and Blair avenues.
- WITKOWSKY, H. ROBERTS (M) designer and body engineer, Fisher Body Corporation, Detroit, Mich.
- WOODWARD, W. L. (J) plant manager, Standard Parts Co., Cleveland Ohio. (mail) 12907 Clifton Boulevard.